Flad Architects

Gov. Juan F. Luis Hospital & Medical Center

St. Croix U.S. Virgin Islands

JFL 5 Acre Parcel Development

Christiansted, St. Croix, Virgin Islands, United States

Flad Project No.23245-00 July 21, 2023

Procurement Package Volume 2

Flad Architects

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SECTION 00 0105 CERTIFICATIONS PAGE

CIVIL

I hereby certify that the plans and specifications for Civil Engineering Work were prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of U.S. Virgin Islands.

Name

Registration No.

LANDSCAPE ARCHITECTURE

I hereby certify that the plans and specifications for Landscape Work were prepared by me or under my direct supervision and that I am a duly Licensed Landscape Architect under the laws of the State of U.S. Virgin Islands.

Name

Registration No.

ARCHITECTURAL

I hereby certify that the plans and specifications for Architectural Work were prepared by me or under my direct supervision and that I am a duly Licensed Architect under the laws of the State of U.S. Virgin Islands.

Name

Registration No.

STRUCTURAL

I hereby certify that the plans and specifications for Structural Engineering Work were prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of U.S. Virgin Islands.

Name

Registration No.

Project No. 23245-00 Certifications Page Section 00 0105 - 1

MECHANICAL

I hereby certify that the plans and specifications for Mechanical Work were prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of U.S. Virgin Islands.

Name

Registration No.

HVAC

I hereby certify that the plans and specifications for HVAC Work were prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of U.S. Virgin Islands.

Name

Registration No.

PLUMBING

I hereby certify that the plans and specifications for Plumbing Work were prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of U.S. Virgin Islands.

Name

Registration No.

FIRE PROTECTION

I hereby certify that the plans and specifications for Fire Protection Work were prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of U.S. Virgin Islands.

Name

Registration No.

ELECTRICAL

I hereby certify that the plans and specifications for Electrical Work were prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of U.S. Virgin Islands.

Name

Registration No.

ELECTRONIC SAFETY AND SECURITY

I hereby certify that the plans and specifications for Electronic Safety and Security Work were prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of U.S. Virgin Islands.

Name

Registration No.

END OF SECTION

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SECTION 00 0110 TABLE OF CONTENTS

VOLUME I

PROCUREMENT AND CONTRACTING REQUIREMENTS

DIVISION 00 -- PROCUREMENT AND CONTRACTING REQUIREMENTS

00 0105 - Certifications Page

00 0110 - Table of Contents

SPECIFICATIONS

DIVISION 01 -- GENERAL REQUIREMENTS

- 01 1000 Summary
- 01 2300 Alternates
- 01 2500 Substitution Procedures
- 01 2500.13 Substitution Request Form
- 01 2600 Contract Modification Procedures
- 01 2613 Requests for Information
- 01 2900 Payment Procedures
- 01 3100 Project Management and Coordination
- 01 3300 Submittal Procedures
- 01 4000 Quality Requirements
- 01 4216 Definitions
- 01 4533 Special Inspection Requirements
- 01 5000 Temporary Facilities and Controls
- 01 5719 Temporary Environmental Controls
- 01 6000 Product Requirements
- 01 7123 Field Engineering
- 01 7300 Execution
- 01 7419 Construction Waste Management and Disposal
- 01 7700 Closeout Procedures
- 01 7839 Project Record Documents
- 01 9113 General Commissioning Requirements

DIVISION 02 -- EXISTING CONDITIONS

- 02 4100 Demolition
- **DIVISION 03 -- CONCRETE**
 - 03 3000 Cast-in-Place Concrete
 - 03 3543 Polished Concrete Floor Finishing

DIVISION 04 -- MASONRY

04 2200 - Concrete Unit Masonry

DIVISION 05 -- METALS

- 05 0519 Post-Installed Anchors
- 05 1200 Structural Steel Framing

- 05 3100 Steel Decking
- 05 4000 Cold-Formed Metal Framing
- 05 5000 Metal Fabrications
- 05 5213 Pipe and Tube Railings

DIVISION 06 -- WOOD, PLASTICS, AND COMPOSITES

- 06 1000 Rough Carpentry
- 06 1600 Sheathing
- 06 8316 Fiberglass Reinforced Paneling

DIVISION 07 -- THERMAL AND MOISTURE PROTECTION

- 07 0553 Fire and Smoke Assembly Identification
- 07 1900 Water Repellents
- 07 2100 Thermal Insulation
- 07 2700 Air Barriers
- 07 5400 Thermoplastic Membrane Roofing
- 07 6200 Sheet Metal Flashing and Trim
- 07 7100 Roof Specialties
- 07 7123 Manufactured Gutters and Downspouts
- 07 8413 Penetration Firestopping
- 07 8443 Joint Firestopping
- 07 9200 Joint Sealants
- 07 9219 Acoustical Joint Sealants

DIVISION 08 -- OPENINGS

- 08 1113 Hollow Metal Doors and Frames
- 08 1116 Aluminum Doors and Frames
- 08 1423.17 Plastic-Faced Wood Doors
- 08 3323 Overhead Coiling Doors
- 08 5113 Aluminum Windows
- 08 7100 Door Hardware
- 08 7113 Automatic Door Operators
- 08 8000 Glazing
- 08 9100 Louvers

DIVISION 09 -- FINISHES

- 09 2216 Non-Structural Metal Framing
- 09 2900 Gypsum Board
- 09 5100 Acoustical Ceilings
- 09 6513 Resilient Base and Accessories
- 09 6516.33 Rubber Sheet Flooring
- 09 9113 Exterior Painting
- 09 9123 Interior Painting
- 09 9153 Floor Marking Paint

DIVISION 10 -- SPECIALTIES

- 10 1423 Panel Signage
- 10 2800 Toilet and Bath Accessories
- 10 4400 Fire Protection Specialties
- 10 5613 Metal Storage Shelving
- 10 7313 Awnings
- 10 7500 Flagpoles

DIVISION 11 -- EQUIPMENT

- 11 1136 Vehicle Charging Equipment
- 11 8226 Facility Waste Compactors

DIVISION 12 -- FURNISHINGS

- 12 2400 Window Shades
- 12 3200 Manufactured Wood Casework
- 12 3600 Countertops

DIVISION 21 -- FIRE SUPPRESSION

- 21 0100 Basis Fire Protection Requirements
- 21 0500 Common Work Results for Fire Suppression
- 21 0548 Vibration and Seismic Control for Fire Suppression Piping
- 21 1100 Facility Fire Suppression Water Service Piping
- 21 1200 Fire-Suppression Standpipes
- 21 1313 Wet-Pipe Sprinkler Systems
- 21 1316 Dry-Pipe and Preaction Sprinkler Systems
- 21 2200 Clean-Agent Fire-Extinguishing System
- 21 3113 Electric Drive Centrifugal Fire Pumps
- 21 3400 Pressure Maintenance Pumps
- 21 3900 Controllers for Fire Pump Drives

VOLUME II

DIVISION 22 -- PLUMBING

- 22 0100 Basic Plumbing Requirements
- 22 0500 Common Work results for Plumbing
- 22 0519 Meters and Gauges for Plumbing Piping
- 22 0523 General-Duty Valves for Plumbing Piping
- 22 0529 Hangers and Supports for Plumbing Piping and Equipment
- 22 0548 Vibration and Seismic Controls for Plumbing Piping and Equipment
- 22 0553 Identification for Plumbing Piping and Equipment
- 22 0700 Plumbing Insulation
- 22 0800 Commissioning of Plumbing
- 22 1113 Facility Fuel Oil Piping
- 22 1114 Liquified Petroleum Gas

- 22 1116 Domestic Water Piping
- 22 1119 Domestic Water Piping Specialties
- 22 1120 Domestic Water Piping Specialties
- 22 1121 Domestic Water Booster Pump
- 22 1316 Sanitary Waste and Went Piping
- 22 1319 Sanitary Waste Piping Specialties
- 22 1413 Facility Storm Drainage Piping
- 22 1423 Storm Drainage Piping Specialties
- 22 1429 Sump Pumps
- 22 1513 General Service Compressed Air Piping
- 22 1519 General Service Packaged Air Compressors And Receivers
- 22 3100 Domestic Water Softeners
- 22 4000 Plumbing Fixtures
- 22 4300 Healthcare Plumbing Fixtures
- 22 4500 Emergency Plumbing Fixtures
- 22 5216 Condensing Boilers
- 22 6113 Medical Air Piping for Healthcare Facilities
- 22 6119 Medical Air Equipment for Healthcare Facilities
- 22 6213 Vacuum Piping for Healthcare Facilities
- 22 6219 Vacuum Equipment for Healthcare Facilities
- 22 6313 Gas Piping for Healthcare Facilities
- 22 6411.1 Facility Fuel Oil Piping
- 22 6413.1 Facility Fuel Oil Pumps
- 22 6700 Processed Water Systems for Healthcare Facilities
- 22 6719 Processed Water Equipment for Laboratory and Healthcare Facilities

DIVISION 23 -- MECHANICAL

- 23 0100 Basic Mechanical Requirements
- 23 0500 Common Work Results for HVAC
- 23 0513 Common Motor Requirements for HVAC Equipment
- 23 0515 Variable Frequency Drives
- 23 0516 Expansion Fittings and Loops for HVAC Piping
- 23 0519 Meters and Gauges for HVAC Piping
- 23 0523 General-Duty Valves for HVAC Piping
- 23 0529 Hangers and Supports for HVAC Piping and Equipment
- 23 0548 Vibration and Seismic Controls for HVAC Piping and Equipment
- 23 0548.13 Vibration Controls for HVAC
- 23 0553 Identification for HVAC Piping and Equipment
- 23 0593 Testing, Adjusting, and Balancing for HVAC
- 23 0700 HVAC Insulation
- 23 0800 Commissioning of HVAC

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 23245-00 Table of Contents Section 00 0110 - 4

- 23 0900 Instrumentation and Control for HVAC
- 23 2113 Hydronic Pumps
- 23 2213 Polypropylene Heating and Cooling Piping
- 23 2213 Steam and Condensate Piping
- 23 2223 Steam Condensate Pumps
- 23 3113 Metal Ducts
- 23 3300 Air Duct Accessories
- 23 3413 Axial HVAC Fans
- 23 3416 Centrifugal HVAC Fans
- 23 3423 HVAC Power Ventilators
- 23 3600 Air Terminal Units
- 23 3713 Diffusers, Registers and Grilles
- 23 3714 Operation Room Single Large Diffuser System
- 23 3723 HVAC Gravity Ventilators
- 23 4100 Particulate Air Filtration
- 23 4133 High-Efficiency Particulate Filtration
- 23 5216 Condensing Boilers
- 23 6416 Centrifugal Water Chillers
- 23 6500 Cooling Towers
- 23 6700 Direct Digital Controls Systems
- 23 7313 Modular Indoor Central Station Air Handling Units
- 23 7323 Custom Indoor Central Station Air Handling Units
- 23 8150 Variable Refrigerant Flow VRF HVAC Equipment
- 23 8219 Fan Coil Units

DIVISION 26 -- ELECTRICAL / SAFETY & SECURITY

- 26 0100 Basic Electrical Requirements
- 26 0500 Tests and Performance Verification
- 26 0513 Wires and Cables
- 26 0526 Grounding
- 26 0529 Raceways and Conduit
- 26 0533 Outlet Boxes
- 26 0548 Vibration and Seismic Controls for Electrical Systems
- 26 0553 Electrical Identification
- 26 0800 Commissioning of Electrical
- 26 2200 Energy Efficient Transformers
- 26 2416 Panelboards
- 26 2726 Wiring Devices
- 26 2816 Safety Switches
- 26 2913 Motor Controllers
- 26 3213 Exterior Engine Generators

26 3600 - Automatic Transfer Switches (Up to 600V)

26 4113 - Lightning Protection System

26 4313 - Transient Voltage Surge Suppressors

DIVISION 27 -- COMMUNICATIONS

- 27 0010 Technology Systems General Provisions
- 27 0526 Bonding for Telecommunications Systems
- 07 0528 Pathways and Spaces for Structured Cabling Systems
- 07 0548 Seismic Controls for Communications Systems
- 27 1000 Structured Cabling System
- 27 1126 Communications Rack Mounted Power Protection and Power Strips
- 27 4100 Audiovisual Systems
- 27 4100 Audio Visual Systems
- 27 4134 Broadband Distribution System
- 27 4135 CATV Headend
- 27 4136 Interactive Patient Room System
- 27 4137 Real Time Locating System
- 27 4138 RF Systems Infrastructure
- 27 5113 Public Address Background Music System
- 27 5119 Sound Masking Systems
- 27 5223 Nurse Call System

DIVISION 28 -- ELECTRONIC SAFETY AND SECURITY

- 28 0537 Security Voice Communications Distributed Antenna System
- 28 1000 Security System
- 28 1010 Intrusion Detection System
- 28 2000 Closed Circuit Television/Video Surveillance System
- 28 3111 Addressable Fire Alarm System
- 28 3115 Fire Alarm Graphic Workstation

DIVISION 31 -- EARTHWORK

- 31 0000 Earthwork
- 31 1001 Site Preparation
- 31 2013 Earth Moving for Buildings
- 31 2319 Dewatering
- 31 2334 Excavation and Backfilling for Structures
- 31 2335 Excavating and Backfilling for Structures
- 31 2500 Erosion and Sedimentation Control

DIVISION 32 -- EXTERIOR IMPROVEMENTS

- 32 1123 Aggregate Base Courses
- 32 1130 Subgrade Stabilization
- 32 1216 Asphalt Concrete Paving
- 32 1600 Curbs, Gutters, Sidewalks, and Driveways

32 1723 - Pavement Markings

32 1731 - Steel Guardrail

32 3113 - Chain Link Fences and Gates

32 3136 - Security Gates and Barriers

DIVISION 33 -- UTILITIES

33 0526 - Pipe Identification

33 1110 - Potable and Reuse Water Distribution Systions

33 3313 - Sanitary Sewer Gravity Systems

33 4000 - Storm Sewer Systems

END OF SECTION

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SECTION 22 0100 BASIC PLUMBING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Basic Requirements: Requirements of the Contract Forms, Conditions of the Contract, Specifications, Drawings, and Addenda and Contract Modifications (the Contract Documents), apply to the requirements of each Section of Division 23.
- B. Conflicts: Nothing contained in this Section shall be construed to conflict in any way with other provisions or requirements of the Contract documents. The intent is that this Section will take precedence. Where differences arise, the Architect shall decide which directions or instructions take precedence.

1.2 SUMMARY

A. General: Unless an item is specifically mentioned as being provided by others, the requirements of Division 23 Contract Documents shall be completed. The systems, equipment, devices and accessories shall be installed, finished, tested and adjusted for continuous and proper operation. Any apparatus, material or device not shown on the Drawings but mentioned in these Specifications, or vice versa, or any incidental accessories necessary to make the project complete and operational in all respects, shall be furnished, delivered and installed without additional expense to the Owner. Include all materials, equipment, supervision, operation, methods and labor for the fabrication, installation, start-up and tests necessary for complete and properly functioning systems.

1.3 APPLICABLE STANDARDS

- A. Code Compliance: Refer to Division 1. As a minimum, unless otherwise indicated, comply with all rules, regulations, standards, codes, ordinances and laws of local, state and federal governments and the amendments and interpretation of such rules, regulations, standards, codes, ordinances and laws of local, state and federal governments by the authorities having lawful jurisdiction.
- B. ADA: Comply with the requirements of the Americans with Disabilities Act (ADA).
- C. Comply: With the National Fire Protection Association (NFPA) Standards and other Codes and Standards as adopted by the Local Authority having Jurisdiction.
- D. Florida Building Code 2020 Edition: Conform in strict compliance to the Florida Building Code (FBC) and the amendments which are enforced by the local authority having jurisdiction.
 - 1. Florida Building Code Mechanical 2020 Edition
 - 2. Florida Building Code Plumbing 2020 Edition
 - 3. Florida Building Code Fuel Gas 2020 Edition
 - 4. Florida Building Code Chapter 13 Florida Energy Efficiency for Building Construction 2020 Edition
 - 5. FGI Guidelines for Design and Construction of Healthcare Facilities, 2018 Edition.
- E. NATIONAL FIRE PROTECTION (NFPA) Standards:
 - 1. NFPA-54, National Fuel Gas Code, 2018 Edition

- 2. NFPA-58, Standard for Storage and Handling of Liquefied Petroleum Gases, 2017 Edition
- 3. NFPA-70, National Electrical Code, 2017 Edition
- 4. NFPA-99, Standard for Health Care Facilities, 2018 Edition
- 5. NFPA-101, Life Safety Code, 2018 Edition
- F. Notification: Comply with all of the requirements of the Federal "Right-To-Know" Regulations and the Florida "Right-To-Know" Law and provide notification to all parties concerned as to the use of toxic substances.
- G. Owner Design Guidelines: Comply with all the requirements of the latest Owner MEP Engineering Design Guidelines and the latest Owner Architectural Construction Standards.

1.4 DRAWINGS AND SPECIFICATIONS

- A. Intent: The intent of the drawings and specifications is to establish minimum acceptable quality standards for materials, equipment and workmanship, and to provide operable mechanical systems complete in every respect.
- B. Equipment Placement: The drawings are diagrammatic, intended to show general arrangement, capacity and location of various components, equipment and devices. Each location shall be determined by reference to the general building plans and by actual measurements in the building as built. Reasonable changes in locations ordered by the Architect prior to the performance of the affected Work shall be provided at no additional cost to the Owner.
- C. Drawing Scale: Due to the small scale of the drawings, and to unforeseen job conditions, all required offsets, transitions and fittings may not be shown but shall be provided at no additional cost.
- D. Conflict: In the event of a conflict, the Architect will render an interpretation in accordance with the General Conditions.

1.5 DEFINITIONS

- A. Provide/Install: The word "provide" shall mean furnish, install, connect, test, complete, and leave ready for operation. The word "install" where used in conjunction with equipment furnished by the Owner or under another contract shall mean mount, connect, complete, and leave ready for operation.
- B. Concealed: The surface of insulated or non-insulated piping, ductwork or equipment is concealed from view when standing inside a finished room, such as inside a chase or above a ceiling.
- C. Exposed: The surface of insulated or non-insulated piping, ductwork or equipment is seen from inside a finished room, such as inside an equipment or air handling unit room.
- D. Protected: The surface of insulated or non-insulated piping, ductwork or equipment on the exterior of the building but protected from direct exposure to rain by an overhang, eave, in an unconditioned parking garage or building crawl space.
- E. Unprotected: The surface of insulated or non-insulated piping, ductwork or equipment on the exterior of the building and exposed to rain.

F. Abbreviations: Abbreviations, where not defined in the Contract Documents, shall be interpreted to mean the normal construction industry terminology, as determined by the Architect. Plural words shall be interpreted as singular and singular words shall be interpreted as plural where applicable for context of the Contract Documents.

1.6 SHOP DRAWINGS

- A. General: Refer to paragraph entitled "SUBMITTAL" in this section. Include the following data:
 - 1. Shop Drawings:
 - a. Submit shop drawings for the following:
 - (1) Each Piping System
 - (2) Coordination Drawings

1.7 RECORD DRAWINGS

- A. Production: Maintain one set of black or blue line on white project record "as-built" drawings at the site. At all times the set shall be accurate, clear, and complete, indicating the actual installation. Record drawings shall be updated weekly to record the present stage of progress. These drawings shall be available to the Architect at all times. Equipment schedules, control diagrams, sequences of operation shall also be updated.
- B. Completion: Prior to substantial completion, transfer onto an unmarked second set of drawings all changes, marked in colored pencil, and submit them to the Architect. Upon completion of all punch lists, transfer all "As-Built" conditions to the Revit drawing files, package three (3) print sets of full size drawings and two (2) CDs of the Revit drawing files with associated reference files and submit them to the Architect for review and approval.

1.8 SUBMITTAL

- A. General: The provisions of this section are supplemental to the requirements in Division 1, and only apply to the material and equipment covered in Division 23.
- B. Time: Submit manufacturer's literature, performance data and installation instructions covered in each Section of Division 23 under an individual letter of transmittal within 30 days after Notice to Proceed unless otherwise indicated.
- C. Submitter's Review: All items required for each section shall be reviewed before submittal. Submittal information for each item shall bear a review stamp of approval, indicating the name of the Contractor and Subcontractor (where applicable), the material suppliers, the initials of submitter and date checked. Responsibility for errors or omissions in submittals shall not be relieved by the Architect's review of submittals. Responsibility for submittals cannot be subrogated to material suppliers by Contractors or Subcontractors.
 - 1. Review of the submittal data, whether indicated with "APPROVED" or with review comments, does not constitute authorization for or acceptance of a change in the contract price.

- D. Architect's Review: The submittal data shall be reviewed only for general conformance with the design concept of the project and for general compliance with the Contract Documents. Any action indicated is subject to the requirements of the Contract Documents. Reviews of submittal data review shall not include quantities; dimensions (which shall be confirmed and correlated at the job site); fabrication processes; techniques of construction; and co-ordination of the submittal data with all other trades. Copies of the submittal data will be returned marked "ACCEPTED AS SUBMITTED", "ACCEPTED AS NOTED", "REVISED AS NOTED AND RESUBMIT", "REJECTED, REVISED AS NOTED AND RESUBMIT".
- E. Submittal Items: Submittal items shall be inserted in a Technical Information Brochure. Mark the appropriate specification section or drawing reference number in the right hand corner of each item. All typewritten pages shall be on the product or equipment manufacturer's printed letterhead.
 - 1. Manufacturer's Literature: Where indicated, include the manufacturer's printed literature. Literature shall be clearly marked to indicate the item intended for use.
 - 2. Performance Data: Provide performance data, wiring and control diagrams and scale drawings which show that proposed equipment will fit into allotted space (indicate areas required for service access, connections, etc.), and other data required for the Architect to determine that the equipment complies with the Contract Documents. Where noted, performance data shall be certified by the manufacturer at the design rating points.
 - 3. Installation Instructions: Where requested, each product submittal shall include the manufacturer's installation instructions. Generic installation instructions are not acceptable. Instructions shall be the same as those included with the product when it is shipped from the factory.
 - 4. Written Operating Instructions: Instructions shall be the manufacturer's written operating instructions for the specified product. If the instructions cover more than one model or type of product they shall be clearly marked to identify the instructions that cover the product delivered to the project. Operating Instructions shall be submitted immediately after the product or equipment submittal has been returned from the Architect marked "APPROVED" or "APPROVED AS NOTED".
 - 5. Maintenance Instructions: Information shall be the manufacturer's printed instructions and parts lists for the equipment furnished. If the instructions cover more than one model or type of equipment they shall be marked to identify the instructions for the furnished product. Submit maintenance instructions immediately after the product or equipment submittal has been returned from the Architect marked "APPROVED" or "APPROVED AS NOTED".
- F. Substitutions:
 - 1. General: Refer to Division 1. Substitutions may be considered for any product or equipment of a manufacturer. See paragraph entitled "MANUFACTURER" in this Section. Any product or equipment may be submitted for review; however, only one substitution per item will be considered. If a substituted product or equipment item is rejected, provide the specified product or equipment.
 - a. Submittal shall include the name of the material or equipment to be substituted, equipment model numbers, drawings, catalog cuts, performance and test data and any other data or information necessary for the Architect to

determine that the equipment meets the specification requirements. If the Architect accepts any proposed substitutions, such acceptance will be set forth in writing.

- b. Substituted equipment with all accessories installed or optional equipment where permitted and found acceptable, must conform to space requirements. Substituted equipment that cannot meet space requirements, whether accepted or not, shall be replaced at no additional expense to the Owner. If the substituted item affects the work of other trades, the Request for Substitution form shall include a list of the necessary modifications.
- 2. Deviations: The Request for Substitution form shall include a complete list of deviations from the scheduled item stating both the features and functions of the scheduled item and the comparable features and functions of the proposed substitution.
 - a. Any deviation not indicated in writing will be assumed to be identical to the specified item even if it is shown otherwise on the submittal data.
 - b. If a deviation not listed is found anytime after review and acceptance by the Architect and that deviation, in the opinion of the Architect, renders the substituted item as unacceptable, the item shall be removed and replaced by the scheduled item at no additional cost to the Owner.
 - c. The Architect shall retain the right to specify modifications to the substituted item, correcting or adjusting for the deviation, if the Architect deems it to be in the best interest of the Owner.
- 3. Scheduled Item: A scheduled item is a product or item of equipment indicated in the Contract Documents by manufacturer's name and model number identifying a single item. The manufacturer's trade name for a group of products that does not signify a single item including type, style, quality, performance, and sound rating shall not be classified as a scheduled item. Where more than one manufacturer and product model number are indicated, each shall be considered as a scheduled item.
- 4. Form: When a product or item of equipment is proposed as a substitution a "REQUEST FOR SUBSTITUTION" form shall be completed and submitted with the required data. A copy of the form is included after the end of this section.
- 5. Rejection: Substituted products or equipment will be rejected if, in the opinion of the Architect, the submittal does not meet any one of the following conditions or requirements:
 - a. The submittal data is insufficient or not clearly identified. The Architect may or may not request additional information.
 - b. The product or equipment will not fit the space available and still provide the manufacturers published service area requirements.
 - c. The product or equipment submitted is not equivalent to or better than the specified item. Products or equipment of lesser quality may be considered provided an equitable financial rebate, satisfactory to the Architect, is to be returned to the Owner.
 - d. The product or equipment submitted has less capacity, efficiency and safety provisions than the specified item.
 - e. The product or equipment submitted does not have warranty, service and factory representation equivalent to that specified.
 - f. The Owner prefers not to accept the submitted product.
- G. Technical Information Brochure:

- Binder: Include binders with the first submittal for the Technical Information Brochure. Each binder shall be size 3 inch, hardcover, 3-ring type for 8-1/2" X 11" sheets. Provide correct designation on outside cover and on spine of each binder, i.e., PLUMBING SUBMITTAL DATA, PLUMBING OPERATION INSTRUCTION and PLUMBING MAINTENANCE INSTRUCTIONS.
- 2. Number: Submit not less than five sets of binders for each of the three mechanical brochures indicated above. Each set shall consist of a minimum of two binders for submittal data and 1 binder each for operating instructions and for maintenance instructions. Additional binders shall be submitted at the request of the Architect. One set of binders shall be retained by the Architect. Three sets of binders shall be maintained for the Owner and the remaining set shall become the property of the Engineer.
- 3. Index: First sheet in each brochure shall be a photocopy of the "Division 22 Index" of the specifications. Second sheet shall list the firm name, address, phone number, superintendent's name for the contractor and all major subcontractors and suppliers associated with the project.
- 4. Dividers: Provide reinforced separation sheets tabbed with the appropriate specifications Section reference number for each Section in which submittal data or operation and maintenance instructions is required.
- 5. Specifications: Insert a copy of the specifications for each Section and all addenda applicable to the Section between each of the Section dividers.

1.9 SHOP DRAWINGS FOR PIPING SYSTEMS

- A. Requirements: Make Shop Drawings for piping systems at a minimum scale of 1/4 inch per foot in Revit and print on reproducible transparencies to verify clearances and equipment locations. Show required maintenance and operational clearances. Identify Shop Drawings by project name and include names of Architect, Engineer, Contractors, Subcontractors and supplier, date in Shop Drawing title block. Number drawings sequentially and indicate:
 - 1. Architectural and structural backgrounds with room names and numbers, etc., including but not limited to plans, sections, elevations, details, etc.
 - 2. Fabrication and erection dimensions.
 - 3. Arrangements and sectional views.
 - 4. Necessary details, including complete information for making connections to equipment.
 - 5. Descriptive names of equipment.
 - 6. Modifications and options to standard equipment required by Contract Documents.
- B. Stamp Area: Leave 4 inch by 2-1/2 inch blank area near title block for Architect's shop drawing stamp. The acceptance of a shop drawing by indicating "APPROVED" does not relieve the contractor from full compliance with the sizes and equipment connections shown on the contract documents unless the changes are specifically indicated on the shop drawing.
- C. Reference Key: Indicate by cross-reference the Contract Drawings, notes, or Specification paragraph numbers where item(s) occur in the Contract Documents.
- D. Additional Requirements: See specific Sections for additional requirements.

1.10 COORDINATION DRAWINGS

- A. General: Provide detailed (minimum 1/4 inch per foot) scaled coordination drawings showing locations and positions of all architectural, structural, (FF&E) equipment, electrical, plumbing, fire protection and mechanical elements for all installations. Provide overlay drawings, prior to beginning work, indicating work in and above ceilings and in mechanical and electrical rooms with horizontal and vertical dimensions, to avoid interference with structural framing, ceilings, partitions and other services. Accommodate phasing and temporary conditions indicated on the contract drawings as necessary to complete the work without disruption to the Owner's use of the existing occupied areas of the building(s).
- B. Coordination of Space: Coordinate use of project space and sequence of installation of mechanical and electrical work which is indicated diagrammatically on drawings. Follow routings shown for pipes, ducts and conduits as closely as practicable, with due allowance for available physical space; make runs parallel with lines of building. Utilize space efficiently to maximize accessibility for other installations, for maintenance, and for repairs.

In finished areas except as otherwise shown, conceal pipes, ducts, and wiring in construction. Coordinate locations of fixtures and outlets with finish elements. Contractor shall provide background drawings showing partitions, ceiling heights, and structural framing locations and elevations, and existing obstructions. Contractor shall resolve major interferences at initial coordination meeting prior to production of coordination drawings.

- C. Precedence of Services: In event of conflicts and interferences involving location and layout of work, use the following priority to resolve interferences:
 - 1. Structure has highest priority.
 - 2. Walls systems.
 - 3. Ceiling grid/light fixtures.
 - 4. Gravity drainage lines.
 - 5. Large pipe mains.
 - 6. Ductwork/diffusers, registers and grilles.
 - 7. Sprinkler heads.
 - 8. Small piping and tubing/electrical conduit.
 - 9. Access panels.
- D. Drawings shall be developed on Revit and utilize AIA Standard layering conventions. At the completion of the project construction, the Contractor shall provide two (2) full-sized print sets and two (2) CDs of all drawing files with related reference files representing asbuilt installations for Architect review. Upon approval that the submitted information is complete, a similar submittal shall be provided to the Owner.
- E. Reference Key: Indicate by cross-reference the Contract Drawings, notes, or Specification paragraph numbers where item(s) occur in the Contract Documents.
- F. Additional Requirements: See specific Sections for additional requirements.

1.11 MANUFACTURER'S CHECKOUT

A. Start-up and Checkout: At completion of installation and prior to performance verification, a factory-trained representative of the manufacturer shall provide start-up and checkout service. After the performance verification the manufacturer's representative shall examine performance information and check the equipment in operation, and sign "Check-Out Memo" for the record. Submit a copy of Memo on each item of equipment

where indicated in individual sections of these specifications for inclusion in each Technical Information Brochure. The "Check-Out Memo" shall be included with the performance verification data. Do not request "Instruction in Operation Conference" or request final inspection until Memos have been submitted and found acceptable.

1.12 INSTRUCTION TO OWNER

- A. General: Instructions to the Owner shall be by competent representatives of the manufacturers involved, with time allowed for complete coverage of all operating procedures. Provide classroom instruction and field training in the design, operation and maintenance of the equipment and troubleshooting procedures. Explain the identification system, operational diagrams, emergency and alarm provisions, sequencing requirements, seasonal provisions, security, safety, efficiency and similar provisions of the systems. On the date of substantial completion, turn over the prime responsibility for operation of the mechanical equipment and systems to the Owner's operating personnel.
- B. Training Period: Unless otherwise indicated training periods shall encompass the following number of hours of classroom and hands-on instructions with a maximum period of 4 hours per day for either. Mixing classroom instructions and hands on training in the same day is unacceptable.
 - 1. Training Periods:
 - a. 8 hours Classroom
 - b. 4 hours Hands-on
- C. Scheduling: Submit any remaining required items for checking at least one week before final inspection of building. When submittal items are found acceptable, notify Owner, in writing that an "Instruction in Operation Conference" may proceed. Conference will be scheduled by the Owner. After the conference, copies of a memo certifying that the "Instruction in Operation Conference" and "Completed Demonstration" have been made will be signed by Owner and the instructors, and one copy will be inserted in each Technical Information Brochure.

1.13 ALLOWANCES

A. General: Division 1.

1.14 ALTERNATES

A. Refer to Division 1.

1.15 STRUCTURAL CALCULATIONS FOR ROOF-MOUNTED EQUIPMENT

A. All roof-mounted devices, equipment and systems shall be constructed, designed and fastened to withstand wind loads of velocities up to 155 mph. Structural calculations for roof-mounted equipment shall be completed in accordance with Florida Building Code requirements and submitted by a structural engineer registered in the State of Florida.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Specified Products: Manufacturer's names and product model numbers indicated on the drawings and in these specifications establish the type, style, quality, performance, and

sound rating of the desired product. Listing of other manufacturers indicates that their equivalent products would be acceptable if they meet the specification requirements, the specific use and installation shown on the drawings, including space and clearance requirements, and the energy consumption and efficiency of the specified product. The listing of additional manufacturers in no way indicates that the manufacturer can provide an acceptable product.

B. Space Requirements: All manufactured products furnished on this project must have the required space and service areas indicated in the manufacturer's printed literature or shown on their shop drawing. When the manufacturer does not indicate the space required for servicing the equipment, the space shown on the drawings or as required by the Architect must be provided.

2.2 MATERIAL AND EQUIPMENT

- A. General: Material and equipment used shall be produced by manufacturers regularly engaged in the production of similar items, and with a history of satisfactory use as judged by the Architect.
- B. Specified Equipment: Equipment shall be the capacity and types indicated or shall be equivalent in the opinion of the Architect. Material and equipment furnished and installed shall be new, recently manufactured, of standard first grade quality and designed for the specific purpose. Equipment and material furnished shall be the manufacturer's standard item of production unless specified or required to be modified to suit job conditions. Sizes, material, finish, dimensions and the capacities for the specified application shall be published in catalogs for national distribution. Ratings and capacities shall be certified by a recognized rating bureau. Products shall be complete with accessories, trim, finish, safety guards and other devices and details needed for a complete installation and for the intended use and effect.
- C. Compatibility: Material and equipment of one and the same kind, type or classification and used for identical or similar purposes shall be made by the same manufacturer. Where more than one choice is available, select the options which are compatible with other products already selected. Compatibility is a basic general requirement of product selection.
- D. Coordination of Materials: In the event of multiple award packages for the completion of this work, the Contractor shall direct and lead the coordination effort necessary to ensure that all materials and equipment that have moving parts, are procured from the same manufacturer and are the same model as consistent with its use and as required by these specifications.

The Contractor shall additionally ensure that the installation of this material and equipment is consistent for the Owner's use and maintenance, and shall effect necessary adjustments to render the installations consistent.

In the event of dispute, the earlier award package materials, as prescribed by approved submittal documents, shall take precedent in defining the material and equipment coordination requirements of the project.

PART 3 - EXECUTION

3.1 WORKMANSHIP

- A. General: The installation of materials and equipment shall be done in a neat, workmanlike and timely manner by an adequate number of craftsmen knowledgeable of the requirements of the Contract Documents. They shall be skilled in the methods and craftsmanship needed to produce a first-quality installation. Personnel who install materials and equipment shall be qualified by training and experience to perform their assigned tasks. All materials and equipment shall be installed per the manufacturer's written requirements.
- B. Acceptable Workmanship: Acceptable workmanship is characterized by first-quality appearance and function which conforms to applicable standards of building system construction and exhibits a degree of quality and proficiency which is judged by the Architect equivalent as or better than that ordinarily produced by qualified industry tradesmen.
- C. Performance: Personnel shall not be used in the performance of the installation of material and equipment that, in the opinion of the Architect, are deemed to be careless or unqualified to perform the assigned tasks. Material and equipment installations not in compliance with the Contract Documents, or installed with substandard workmanship in the opinion of the Architect, shall be removed and reinstalled by qualified craftsmen at no change in the contract price.

3.2 CLEANING AND PROTECTION

- A. General: Refer to Division 1.
- B. Emergency Contacts: Prior to the beginning of the project, provide the Owner with a list of names, emergency telephone and beeper numbers of individuals who can be contacted during working and non-working hours, including weekends, for assistance throughout the warranty period if leaks, equipment failure or other damages occur. Update the list throughout installation and warranty to provide continuous availability of responsible parties to the Owner. If the Owner cannot contact the responsible party during an emergency situation, the Owner may affect emergency repairs through other means and may backcharge for the costs of repair material and labor incurred.
- C. Emergency Contacts: Along with the operating and maintenance manual submittal, provide the Owner with a list of the names and emergency telephone and beeper numbers of individuals who can be contacted during working and non-working hours, including weekends, for assistance throughout the warranty period should leaks, equipment failure or other damage occur. Update the list throughout warranty to provide continuous availability of responsible parties to the Owner. If the Owner cannot contact the responsible party during an emergency situation, the Owner may affect emergency repairs through other means and may backcharge for the costs of repair material and labor incurred.
- D. Housekeeping: Keep interiors of duct and pipe systems clean and free from dirt, rubbish and foreign matter. Close open ends of piping and ductwork at all times throughout the installation. Install 30% efficient filter media over each return air grille and open return duct opening; change media regularly during construction when dirty to keep duct interiors clean. Prevent dust, debris and foreign material from entering the piping and ductwork.
- E. Equipment Protection: Protect fan motors, switches, equipment, fixtures, and other items from dirt, rubbish and foreign matter. Do not operate air-handling equipment if the building is not clean or if dust can enter the coils or the fan housings.

- F. Equipment Cleaning: Thoroughly clean equipment and entire piping systems internally upon completion of installation and immediately prior to final acceptance. Open dirt pockets and strainers, blow down each piping system and clean strainer screens of accumulated debris. Remove accumulated dirt, scale, oil and foreign substances. Thoroughly wipe clean internal surfaces of ductwork and air handling units prior to request for substantial completion. (See para. 3.2 above.)
- G. Building Cleanup: Remove debris, rubbish, leftover materials, tools and equipment from work areas and site. Clean tunnels and closed off spaces of packing boxes, wood frame members and other waste materials used in the installation. Final acceptance shall not be approved until site is cleaned.
- H. Fixture Cleanup: Remove temporary labels, stickers, etc., from fixtures and equipment. Do not remove permanent nameplates, equipment model numbers, ratings, etc.
- I. Filter Replacement: Provide filters, with the same efficiency rating as required for the final installation, for the protection of the air moving equipment and ductwork continuously throughout the construction phase. Provide a new set of clean filters for the test and balance of the air side equipment.
- J. Protection of Finished Installation: Where installation is required in areas previously finished by other trades, protect the area from marring, soiling or other damage.

3.3 CORRECTION OF WORK

A. General: At no additional cost to the Owner, rectify discrepancies between the actual installation and contract documents when in the opinion of the Architect the discrepancies will affect system balance and performance.

3.4 COORDINATION AND ASSISTANCE

- A. General: Provide all labor, equipment, tools and material required to operate the equipment and systems necessary for the testing and balancing of the systems and for the adjustment, calibration or repair of all automated control devices and components. These services shall be available on each working day during the period of final testing and balancing.
- B. Drawings and Specifications: Provide to the Architect a complete set of project record drawings and specifications and an approved copy of all shop drawings and equipment submittals. The Architect shall be informed of all changes made to the system during construction, including applicable change orders.
- C. Coordination: Coordinate the work of all trades and equipment suppliers to complete the modifications recommended by the Commissioning Agent and accepted by the Architect. Cut or drill holes for the insertion of air measuring devices as directed for test purposes; repair to as-new condition, inserting plastic caps or covers to prevent air leakage. Repair or replace insulation and re-establish the integrity of the vapor retardant.

3.5 PREPARATIONS FOR PERFORMANCE VERIFICATION

- A. Verification: Prior to commencement of the balancing by the Commissioning Agent, the Contractor shall verify in writing:
 - 1. That strainers have been removed, cleaned and replaced, and that temporary construction strainers have been removed.

- 2. That compression or expansion tanks have been inspected, are not air-bound or water-logged and are pre-charged, and that the piping systems have been completely vented and filled with water.
- 3. That air vents at high points of the piping systems have been inspected and installed and operating freely.
- 4. That automatic valves, hand valves, and balancing valves have been placed in a fixed open position for full flow through all devices.
- 5. That linkages between valves and their actuators are secure, non-overloading and non-binding.
- 6. That pressures for pressure reducing valves have been set.
- 7. That operating temperatures have been set for heat exchangers, regulating valves, etc.
- 8. That pumps are operating at the correct rotation and specified horsepower.
- 9. That piping has been pressure tested and accepted and piping systems have been cleaned, flushed, sterilized and refilled with chemicals and prescribed treated water and vented.
- 10. That operating temperatures have been set for boilers, regulating valves, etc.
- 11. That the operating safeties (thermal overloads, firestat/freezestats, smoke detectors, relief valves, etc.), are installed and fully functional.
- 12. That equipment has been lubricated and can be operated without damage.
- 13. That the systems are operational and complete.
- 14. That no latent residual work remains to be completed.

3.6 ACCEPTANCE TESTING PROCEDURE

- A. General: Each plumbing system shall be tested to confirm proper operation and function in accordance with the construction documents and sequence of operations.
- B. The enclosed checklists shall be completed for each system and signed off by the mechanical sub-contractor project representative, then verified and signed-off by the mechanical sub-contractor project supervisor and the construction manager systems engineer. All checklists shall be incorporated into the project's close-out manuals submitted for Owner record.
- C. On-site testing by the Architect and Engineer shall be performed at the discretion of the Architect/Engineer for any or all systems to confirm test results and system function.
- D. The Contractor is responsible to provide adequate time in the completion of the construction to perform these system tests prior to the AHCA final inspections in the affected areas/systems.
- E. The Contractor is responsible for ensuring all required system tests are conducted successfully and recording associated test data and results.
- F. The Contractor is responsible for contacting the Architect and Engineer at least two weeks prior to system test availability and schedule acceptable to Architect/Engineer for on-site testing.
- G. If, in the Architect's and Engineer's opinion, the test results indicate that the systems' installation is not adequately complete for testing, the testing shall be re-scheduled and the Contractor shall be responsible to prepare for such re-test.
- H. Prior to Owner occupancy, all system testing shall be completed and approved.

3.7 PROTECTION OF MATERIALS AND EQUIPMENT

- A. Requirements: Do not store fiberglass insulation or any equipment within the building until it has been "dried in". If dry space is unavailable and the insulation and equipment must be installed or stored before the building is "dried in" and completely enclosed, provide polyethylene film cover for protection.
- B. Replacement of Damaged Stored Material and Equipment: Any material and equipment that has been wet or otherwise damaged prior to installation, in the opinion of the Architect, shall be replaced with new material regardless of the condition of the material and equipment at the time of installation.
- C. Repair of Damaged Installed Material and Equipment: After installation correct or repair dents, scratches and other visible blemishes. At the direction of Architect replace or repair to "as new" condition equipment which has been damaged during construction.
- D. During construction, all piping and ductwork system openings shall be capped with at least two layers of polyethylene film, fastened tightly in place with banding material or foil tape until connection of the continuation of such piping or ductwork is occurring.
- E. All air diffusers serving critical care areas shall be disinfected per owner infection control guidelines with a commercial germicide complying with EPA regulations utilizing per manufacturer use standards prior to building occupancy.

3.8 COORDINATION OF SERVICES

- A. General: Where phasing of the work requires partial occupancy, coordinate interruption of services to Owner-occupied areas in writing in advance with the Architect. Shutdown time and duration of services interruption shall be decided by the Owner. Provide shutoff valves at points of interconnection to minimize downtime. Procedures incidental to the outage shall be prepared in advance to minimize downtime.
- B. General: Coordinate interruption of services in writing at least 1 week in advance with the Architect. Shutdown time and duration of services interruption shall be decided by the Owner. Provide shutoff valves at points of interconnection to minimize downtime. Procedures incidental to the outage shall be prepared in advance to minimize downtime.
- C. Protection of Facilities: Portions of the building may be operational during construction. Maintain operation of the equipment and systems whenever the installation interfaces with equipment or systems. Provide protection for the building, its contents and occupants wherever installation under the contract is performed. As necessary, move, store, and protect furniture, office fixtures and carpets. Provide acoustical isolation of the work area with temporary doors, partitions, etc., to allow normal work functions. Provide exhaust fans, temporary dust barrier partitions and any containment measures required to prevent dirt, dust or fumes from reaching adjacent occupied spaces as required by the Owner or Architect. Access to the building, including exit stairs, doors and passageways, and loading dock and other delivery areas shall be kept open and continuously accessible to the occupants. Workmen shall be confined to those areas directly involved in the project installation, and only during time periods indicated and approved by the Owner.

3.9 PAINTING OF PIPING

- A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual". Comply with Section 09 123.
 - 1. Use applicators and techniques suited for paint and substrate indicated.

- 2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
- 3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
- 4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating or nomenclature plates.
- 5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple costs of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

If undercoats or other conditions show through topcoat, apply additional costs until cured file has a uniform paint finish, color, and appearance.

- A. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness or other surface imperfections. Cut in sharp lines and color breaks.
- B. Painting of Plumbing work:
 - 1. Paint the following work where exposed in Equipment Rooms:
 - a. Uninsulated metal piping (except copper).
 - b. Uninsulated plastic piping.
 - c. Pipe hangers and supports.
 - d. Tanks that do not have factory applied final finishes.
 - e. Equipment and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
 - 2. Paint the following work where exposed in Occupied Spaces:
 - a. Equipment, including panelboards.
 - b. Uninsulated metal piping (except copper).
 - c. Uninsulated plastic piping.
 - d. Pipe hangers and supports.
 - e. Equipment and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
- 3. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.10 FIELD QUALITY CONTROL

- A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.
 - 1. Contractor shall touch up and restore painted surfaces damaged by testing.

2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.11 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

END OF DOCUMENT 22 0100

REQUEST FOR SUBSTITUTION	(Must be Submitted Prior to Bid)	

Project Name: _____ Location: _____

Date of Request: _____

Name of Party Requesting Substitute:

Reason for Substitution Request:

Drawing	Spec. Sect. No.	Paragraph	Specified Item	<u>Manu</u>	<u>Model</u>
Proposed Su	ubstitute:				
Manufacture	r and Model Number:				

Deviations from the Specified Item: (See paragraph entitled "Deviations".)

Reason for Substitution:

Changes to Other	Systems to Permit Use of Proposed Substitute:
(List changes.	Submit drawings if required for clarity.)

Technical Data to Support Request for Acceptance: (List ASTM or other standards designations, testing laboratory reports, experience records, etc.)

Other Supporting Data: (Submit brochures, samples, drawings, etc.)

REQUEST FOR SUBSTITUTION (Continued)

<u>Certification</u>: In making request for substitution, the party whose authorized signature appears below, certifies that all of the following statements are correct and are accepted without exception:

The proposed substitution has been personally investigated and is equal or superior in all significant respects to the product specified for the specific applications required;

The proposed substitution will be warranted under the same terms required for the specified product;

Coordination aspects necessitated by the proposed substitution will be accomplished in a complete and proper fashion by the party signing this form without any additional cost to the Owner; and

Claims against the Owner for additional costs related to the proposed substitution which subsequently become apparent after acceptance by the Architect are hereby waived.

Credit: If this substitution is acceptable the following credit shall be given to the Owner;

\$ _____

CERTIFICATION OF EQUIVALENT PERFORMANCE AND ASSUMPTION OF LIABILITY FOR EQUIVALENT PERFORMANCE

The undersigned states that the function, appearance and quality are equivalent or superior to the specified item.

Submitted by: _______Signature Title

Typed Name: _____

Company: _____

Signature shall be by person having authority to legally bind his firm to the above terms. Failure to provide a legally binding signature will invalidate this request.

SECTION 22 0500 COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Transition fittings.
 - 3. Dielectric fittings.
 - 4. Mechanical sleeve seals.
 - 5. Sleeves.
 - 6. Escutcheons.
 - 7. Grout.
 - 8. Equipment installation requirements common to equipment sections.
 - 9. Painting and finishing.
 - 10. Concrete bases.
 - 11. Supports and anchorages.

1.3 DEFINITIONS

- A. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- B. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- C. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- D. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- E. The following are industry abbreviations for rubber materials:
 - 1. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Transition fittings.
 - 2. Dielectric fittings.
 - 3. Mechanical sleeve seals.
 - 4. Escutcheons.

B. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.2 JOINING MATERIALS

A. Refer to individual Division 22 piping Sections for special joining materials not listed below.

- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 - 2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and fullface or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for generalduty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- G. Solvent Cements for Joining Plastic Piping:
 - PVC Piping:
 a. ASTM D 2564. Include primer according to ASTM F656.

2.3 TRANSITION FITTINGS

- A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
 - 1. Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
 - b. Dresser Industries, Inc.; DMD Div.
 - c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
 - d. JCM Industries.
 - e. Smith-Blair, Inc.
 - f. Viking Johnson.
 - 2. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.
- B. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve ends same size as piping to be joined, and corrosion-resistant metal band on each end.
 - 1. Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
 - b. Fernco, Inc.
 - c. Mission Rubber Company.

d. Plastic Oddities, Inc.

2.4 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
 - 1. Manufacturers:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company.
 - c. Eclipse, Inc.
 - d. Epco Sales, Inc.
 - e. Hart Industries, International, Inc.
 - f. Watts Industries, Inc.; Water Products Div.
 - g. Zurn Industries, Inc.; Wilkins Div.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
 - 1. Manufacturers:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company.
 - c. Epco Sales, Inc.
 - d. Watts Industries, Inc.; Water Products Div.
- E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
 - 1. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Central Plastics Company.
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.
- F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
 - 1. Manufacturers:
 - a. Calpico, Inc.
 - b. Lochinvar Corp.

2.5 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
 - 1. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Sealing Elements: EPDM or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 3. Pressure Plates: Carbon steel. Include two for each sealing element.
 - 4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.6 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with set screws.

2.7 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chromeplated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
 - 1. Finish: Polished chrome-plated and rough brass.

2.8 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.
PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass type with polished chromeplated finish.
 - c. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
- M. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
- N. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
 - 1. Cut sleeves to length for mounting flush with both surfaces.

- a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
- 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
- 3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
 - b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
 - c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
 - 1) Seal space outside of sleeve fittings with grout.
- 4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
- O. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 - 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
 - 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- P. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- Q. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
- R. Verify final equipment locations for roughing-in.

S. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent Cement Joints:
 - 1. Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - a. Comply with ASTM F402 for safe handling practice of cleaners, primers and solvent cements.
 - b. PVC Non-Pressure Piping: Join according to ASTM D2855.

3.3 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.5 PAINTING

- A. Painting of plumbing systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.6 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and structural drawings.
 - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.8 GROUTING

- A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.

- G. Place grout around anchors.
- H. Cure placed grout.

END OF DOCUMENT 22 0500

SECTION 22 0519 METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Liquid-in-glass thermometers.
 - 2. Thermowells.
 - 3. Dial-type pressure gages.
 - 4. Gage attachments.
 - 5. Test plugs.
 - 6. Test-plug kits.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Product Certificates: For each type of meter and gage, from manufacturer.
- C. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS

- A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Trerice, H. O. Co.
 - b. Weiss Instruments, Inc.
 - c. Winters Instruments U.S.
 - 2. Standard: ASME B40.200.
 - 3. Case: Cast aluminum; 9-inch nominal size unless otherwise indicated.
 - 4. Case Form: Adjustable angle unless otherwise indicated.
 - 5. Tube: Glass with magnifying lens and blue or red organic liquid.
 - 6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
 - 7. Window: Glass.
 - 8. Stem: Aluminum and of length to suit installation.
 - a. Design for Thermowell Installation: Bare stem.

- 9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
- 10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.2 THERMOWELLS

- A. Thermowells:
 - 1. Standard: ASME B40.200.
 - 2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
 - 3. Material for Use with Copper Tubing: CUNI.
 - 4. Type: Stepped shank unless straight or tapered shank is indicated.
 - 5. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
 - 6. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
 - 7. Bore: Diameter required to match thermometer bulb or stem.
 - 8. Insertion Length: Length required to match thermometer bulb or stem.
 - 9. Lagging Extension: Include on thermowells for insulated piping and tubing.
 - 10. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
- B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.3 PRESSURE GAGES

- A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Trerice, H. O. Co.
 - b. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
 - c. Weiss Instruments, Inc.
 - 2. Standard: ASME B40.100.
 - 3. Case: Liquid-filled type(s); cast aluminum or drawn steel; 6-inch nominal diameter.
 - 4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
 - 5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
 - 6. Movement: Mechanical, with link to pressure element and connection to pointer.
 - 7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi and kPa.
 - 8. Pointer: Dark-colored metal.
 - 9. Window: Glass.
 - 10. Ring: Metal.
 - 11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.4 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.
- B. Valves: Brass or stainless-steel needle with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

2.5 TEST PLUGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Trerice, H. O. Co.
 - 2. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
 - 3. Weiss Instruments, Inc.
- B. Description: Test-station fitting made for insertion into piping tee fitting.
- C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
- D. Thread Size: NPS 1/4 ASME B1.20.1 pipe thread.
- E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
- F. Core Inserts: EPDM self-sealing rubber.

2.6 TEST-PLUG KITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Trerice, H. O. Co.
 - 2. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
 - 3. Weiss Instruments, Inc.
- B. Furnish one test-plug kit(s) containing two thermometer(s), one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.
- C. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch-diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F.
- D. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch-diameter dial and probe. Dial range shall be at least 0 to 200 psig.
- E. Carrying Case: Metal or plastic, with formed instrument padding.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.

- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- G. Install valve and snubber in piping for each pressure gage for fluids.
- H. Install test plugs in piping tees.
- I. Install thermometers in the following locations:
 - 1. Outlet of each water heater.
 - 2. Outlets of each domestic water heat exchanger.
 - 3. Inlet and outlet of each domestic hot-water storage tank.
- J. Install pressure gages in the following locations:
 - 1. Inlet and outlet of each pressure-reducing valve.
 - 2. Suction and discharge of each domestic water pump.

3.2 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.3 ADJUSTING

A. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

- A. Thermometers at inlets and outlets of each domestic water heat exchanger shall be one of the following:
 - 1. Industrial-style, liquid-in-glass type.
 - 2. Test plug with EPDM self-sealing rubber inserts.
- B. Thermometers at inlet and outlet of each domestic hot-water storage tank shall be one of the following:
 - 1. Industrial-style, liquid-in-glass type.
 - 2. Test plug with EPDM self-sealing rubber inserts.
- C. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

- A. Scale Range for Domestic Cold-Water Piping: 0 to 100 deg F.
- B. Scale Range for Domestic Hot-Water Piping: 30 to 240 deg F.

3.6 PRESSURE-GAGE SCHEDULE

- A. Pressure gages at inlet and outlet of each water pressure-reducing valve shall be one of the following:
 - 1. Liquid-filled, direct-mounted, metal case.
 - 2. Test plug with EPDM self-sealing rubber inserts.
- B. Pressure gages at suction and discharge of each domestic water pump shall be one of the following:
 - 1. Liquid-filled, direct-mounted, metal case.
 - 2. Test plug with EPDM self-sealing rubber inserts.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Domestic Water Piping: 0 to 150 psi.

END OF DOCUMENT 22 0519

SECTION 22 0523 GENERAL DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following general-duty valves:
 - 1. Copper-alloy ball valves.
 - 2. Ferrous-alloy ball valves.
 - 3. Bronze check valves.
 - 4. Gray-iron swing check valves.
 - 5. Spring-loaded, lift-disc check valves.
 - 6. Bronze gate valves.
 - 7. Cast-iron gate valves.

1.3 DEFINITIONS

- A. The following are standard abbreviations for valves:
 - 1. CWP: Cold working pressure.
 - 2. PTFE: Polytetrafluoroethylene plastic.
 - 3. TFE: Tetrafluoroethylene plastic.

1.4 SUBMITTALS

A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

1.5 QUALITY ASSURANCE

- A. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.
- B. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 VALVES, GENERAL

- A. Refer to Part 3 "Valve Applications" Article for applications of valves.
- B. Bronze Valves: NPS 2 and smaller with threaded ends, unless otherwise indicated.
- C. Ferrous Valves: NPS 2-1/2 and larger with flanged ends, unless otherwise indicated.
- D. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- E. Valve Sizes: Same as upstream pipe, unless otherwise indicated.
- F. Valve Actuators:
 - 1. Handwheel: For valves other than quarter turn types.
 - 2. Lever Handle: For quarter turn valves NPS 6 and smaller, except plug valves.
 - 3. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug heads.
- G. Extended Valve Stems: On insulated valves.
- H. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves and ASME B16.24 for bronze valves.
- I. Valve Grooved Ends: AWWA C606.
 - 1. Solder Joint: With sockets according to ASME B16.18.
 - a. Caution: Use solder with melting point below 840 deg F for angle, check, gate, and globe valves; below 421 deg F for ball valves.
 - 2. Threaded: With threads according to ASME B1.20.1.
- J. Valve Bypass and Drain Connections: MSS SP-45.

2.3 COPPER-ALLOY BALL VALVES

- A. Manufacturers:
 - 1. Two-Piece, Copper-Alloy Ball Valves:
 - a. Apollo Valve
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Div.
 - d. Hammond Valve.
 - e. NIBCO INC.
- B. Copper-Alloy Ball Valves, General: MSS SP-110.
- C. Two-Piece, Copper-Alloy Ball Valves: Brass or bronze body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig minimum CWP rating and blowout-proof stem.

2.4 BRONZE CHECK VALVES

- A. Manufacturers:
 - 1. Bronze, Horizontal Lift Check Valves with Nonmetallic Disc:
 - a. Apollo Valve
 - b. Cincinnati Valve Co.
 - c. Crane Co.; Crane Valve Group; Crane Valves.
 - d. Crane Co.; Crane Valve Group; Stockham Div.
 - 2. Bronze, Vertical Lift Check Valves and Metal Disc:
 - a. Apollo Valve
 - b. Cincinnati Valve Co.
 - c. Crane Co.; Crane Valve Group; Crane Valves.
 - d. Crane Co.; Crane Valve Group; Jenkins Valves.
 - 3. Bronze, Vertical Lift Check Valves with Nonmetallic Disc:
 - a. Apollo Valve
 - b. Grinnell Corporation.
 - c. Kitz Corporation of America.
 - d. Milwaukee Valve Company.
 - 4. Bronze, Swing Check Valves with Nonmetallic Disc:
 - a. Apollo Valve
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Div.
 - d. Hammond Valve.
 - e. Milwaukee Valve Company.
 - f. NIBCO INC.
- B. Bronze Check Valves, General: MSS SP-80.

- C. Bronze, Horizontal Lift Check Valves: Bronze body with nonmetallic disc and bronze seat.
- D. Bronze, Vertical Lift Check Valves: Bronze body with nonmetallic disc and bronze seat.
- E. Bronze, Swing Check Valves: Bronze body with nonmetallic disc and bronze seat.

2.5 GRAY-IRON SWING CHECK VALVES

- A. Manufacturers:
 - 1. Gray-Iron Swing Check Valves with Metal Seats:
 - a. Apollo Valve
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Div.
 - d. Hammond Valve.
 - e. NIBCO INC.
 - 2. Gray-Iron Swing Check Valves with Composition to Metal Seats:
 - a. Apollo Valve
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Div.
 - d. Watts Industries, Inc.; Water Products Div.
- B. Gray-Iron Swing Check Valves, General: MSS SP-71.
- C. Class 125, gray-iron, swing check valves with metal seats.
- D. Class 125, gray-iron, swing check valves with composition to metal seats.

2.6 SPRING-LOADED, LIFT-DISC CHECK VALVES

- A. Manufacturers:
 - 1. Globe Lift-Disc Check Valves:
 - a. Apollo Valve
 - b. Hammond Valve.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
- B. Lift-Disc Check Valves, General: FCI 74-1, with spring-loaded bronze or alloy disc and bronze or alloy seat.

2.7 BRONZE GATE VALVES

- A. Manufacturers:
 - 1. Bronze, Rising-Stem, Solid-Wedge Gate Valves:
 - a. Apollo Valve
 - b. Crane Co.; Crane Valve Group; Crane Valves.

- c. Crane Co.; Crane Valve Group; Stockham Div.
- d. Hammond Valve.
- e. NIBCO INC.
- B. Bronze Gate Valves, General: MSS SP-80, with ferrous-alloy handwheel.
- C. Class 150, Bronze Gate Valves: Bronze body with rising stem and bronze solid wedge.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- D. Examine threads on valve and mating pipe for form and cleanliness.
- E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- F. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE APPLICATIONS

- A. Refer to piping Sections for specific valve applications. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Ball or gate valves.
 - 2. Throttling Service: Ball valves.
 - 3. Pump Discharge: Spring-loaded, lift-disc check valves.
- B. If valves with specified CWP ratings are not available, the same types of valves with higher CWP ratings may be substituted.
- C. Low Pressure, Compressed Air Piping: Use the following types of valves:
 - 1. Ball Valves, NPS 2 and Smaller: Two piece, 400 psig CWP rating, copper alloy.
 - 2. Swing Check Valves, NPS 2 and Smaller: Class 150, bronze.

D. Domestic Water Piping: Use the following types of valves:

- 1. Ball Valves, NPS 2 and Smaller: Two-piece, 400-psig CWP rating, copper alloy.
- 2. Lift Check Valves, NPS 2 and Smaller: Class 150, horizontal or vertical, bronze.
- 3. Swing Check Valves, NPS 2 and Smaller: Class 150, bronze.
- 4. Gate Valves, NPS 2 and Smaller: Class 150, bronze.

- E. Sanitary Waste and Storm Drainage Piping: Use the following types of valves:
 - 1. Swing Check Valves, NPS 2-1/2 and Larger: Class 125, gray iron.
- F. Select valves, except wafer and flangeless types, with the following end connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Solder-joint or threaded ends.
 - 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged or threaded ends.
 - 3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
 - 4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
 - 5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged or threaded ends.
 - 6. For Steel Piping, NPS 5 and Larger: Flanged ends.
 - 7. For Grooved End, Copper Tubing and Steel Piping: Valve ends may be grooved.

3.3 VALVE INSTALLATION

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- C. Locate valves for easy access and provide separate support where necessary.
- D. Install valves in horizontal piping with stem at or above center of pipe.
- E. Install valves in position to allow full stem movement.
- F. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
 - 2. Lift Check Valves: With stem upright and plumb.

3.4 JOINT CONSTRUCTION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for basic piping joint construction.
- B. Grooved Joints: Assemble joints with keyed coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.
- C. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.5 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF DOCUMENT 22 0523

SECTION 22 0529 HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following hangers and supports for plumbing system piping and equipment:
 - 1. Steel pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Thermal-hanger shield inserts.
 - 5. Fastener systems.
 - 6. Pipe stands.
 - 7. Pipe positioning systems.
 - 8. Equipment supports.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel pipe hangers and supports.
 - 2. Fiberglass pipe hangers.
 - 3. Thermal-hanger shield inserts.
 - 4. Pipe positioning systems.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze pipe hangers. Include Product Data for components.
 - 2. Metal framing systems. Include Product Data for components.
 - 3. Fiberglass strut systems. Include Product Data for components.
 - 4. Pipe stands. Include Product Data for components.
 - 5. Equipment supports.
- C. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.
- B. Welding: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1, "Structural Welding Code--Steel."
 - 2. AWS D1.2, "Structural Welding Code--Aluminum."
 - 3. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
 - 4. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- B. Manufacturers:
 - 1. B-Line Systems, Inc.; a division of Cooper Industries.
 - 2. ERICO/Michigan Hanger Co.
 - 3. PHD Manufacturing, Inc.
- C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.
- E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

- A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
- B. Manufacturers:
 - 1. B-Line Systems, Inc.; a division of Cooper Industries.
 - 2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
 - 3. Unistrut Corp.; Tyco International, Ltd.
- C. Coatings: Manufacturer's standard finish unless bare metal surfaces are indicated.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.4 THERMAL-HANGER SHIELD INSERTS

- A. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.
- B. Manufacturers:
 - 1. ERICO/Michigan Hanger Co.
 - 2. PHS Industries, Inc.
 - 3. Pipe Shields, Inc.
- C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with vapor barrier.
- D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate.
- E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

- A. Mechanical-Expansion Anchors: Insert-wedge-type stainless steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 1. Manufacturers:
 - a. B-Line Systems, Inc.; a division of Cooper Industries.
 - b. Hilti, Inc.
 - c. ITW Ramset/Red Head.

2.6 PIPE STAND FABRICATION

- A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Low-Type, Single-Pipe Stand: One-piece plastic base unit with plastic roller, for roof installation without membrane penetration.
 - 1. Manufacturers:
 - a. MIRO Industries.

2.7 PIPE POSITIONING SYSTEMS

A. Description: IAPMO PS 42, system of metal brackets, clips, and straps for positioning piping in pipe spaces for plumbing fixtures for commercial applications.

- B. Manufacturers:
 - 1. C & S Mfg. Corp.
 - 2. HOLDRITE Corp.; Hubbard Enterprises.
 - 3. Samco Stamping, Inc.

2.8 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structuralsteel shapes.

2.9 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use padded hangers for piping that is subject to scratching.
- F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
 - Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
 - 3. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.

- 4. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
- 5. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
 - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
- H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
- I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 - 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
 - 3. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 - 4. C-Clamps (MSS Type 23): For structural shapes.
 - 5. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 - 6. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
- J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 - 2. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

- K. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- L. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- M. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.
- N. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
 - 1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Pipe Stand Installation:
 - 1. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 - 2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 07 Section "Roof Accessories" for curbs.
- G. Pipe Positioning System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. Refer to Division 22 Section "Plumbing Fixtures" for plumbing fixtures.
- H. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

- I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- J. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- K. Install lateral bracing with pipe hangers and supports to prevent swaying.
- L. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- M. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- N. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.
- O. Insulated Piping: Comply with the following:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits according to ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weightdistribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weightdistribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

- 5. Pipes NPS 8 and Larger: Include wood inserts.
- 6. Insert Material: Length at least as long as protective shield.
- 7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

- A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF DOCUMENT 22 0529

JFL - THS 5 ACRE LAND LEASE SI	TE	Project No. 121505
Procurement Package	Hangers and Supports	s for Plumbing Piping and Equipment
07/21/2023	TLC Engineering Solutions	Section 22 0529 - 8

SECTION 22 0548 VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Elastomeric isolation pads.
 - 2. Elastomeric isolation mounts.
 - 3. Restrained elastomeric isolation mounts.
 - 4. Open-spring isolators.
 - 5. Housed-spring isolators.
 - 6. Restrained-spring isolators.
 - 7. Housed-restrained-spring isolators.
 - 8. Pipe-riser resilient support.
 - 9. Resilient pipe guides.
 - 10. Air-spring isolators.
 - 11. Restrained-air-spring isolators.
 - 12. Elastomeric hangers.
 - 13. Spring hangers.
 - 14. Snubbers.
 - 15. Restraints rigid type.
 - 16. Restraints cable type.
 - 17. Restraint accessories.
 - 18. Post-installed concrete anchors.
 - 19. Concrete inserts.
 - 20. Vibration isolation equipment bases.
- B. Related Requirements:
 - 1. Section 21 0548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment" for devices for fire-suppression equipment and systems.
 - 2. Section 23 0548 "Vibration and Seismic Controls for HVAC" for devices for HVAC equipment and systems.

1.3 DEFINITIONS

- A. Designated Seismic System: A plumbing component that requires design in accordance with ASCE/SEI 7, Ch. 13 and for which the Component Importance Factor is greater than 1.0.
- B. IBC: International Building Code.
- C. OSHPD: Office of Statewide Health Planning and Development (for the State of California owned and regulated medical facilities).

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

- 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
- 2. Include load rating for each wind-force-restraint fitting and assembly.
- 3. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic-[and wind-force-]restraint component.
- 4. Annotate types and sizes of seismic restraints and accessories, complete with listing markings or report numbers and load rating in tension and compression as evaluated by [ICC-ES product listing] [UL product listing] [FM Approvals] [an evaluation service member of ICC-ES] [OSHPD] [an agency acceptable to authorities having jurisdiction].
- 5. Annotate to indicate application of each product submitted and compliance with requirements.
- 6. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.
- B. Shop Drawings:
 - 1. Detail fabrication and assembly of equipment bases.
 - 2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
- C. Delegated-Design Submittal:
 - 1. For each seismic-restraint [and] [wind-load protection] device, including [seismic-restrained mounting,] [pipe-riser resilient support,] [snubber,] [seismic restraint,] [seismic-restraint accessory,] [and] [concrete anchor and insert,] that is required by this Section or is indicated on Drawings, submit the following:
 - a. Seismic [and wind-load]restraint, and vibration isolator, and isolation base selection: Select vibration isolators, seismic [and wind-load]restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data.
 - b. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification by professional engineer that riser system was examined for excessive stress and that none exists.
 - c. Concrete Anchors and Inserts: Include calculations showing anticipated seismic and wind loads. Include certification that device is approved by an NRTL for seismic reinforcement use.
 - d. Seismic Design Calculations: Submit all input data and loading calculations prepared in "Performance Requirements" Article in "Seismic Design Calculations" Paragraph.
 - e. Wind-Load Design Calculations: Submit all static and dynamic loading calculations prepared in "Wind-Load Design Calculations" Paragraph in "Performance Requirements" Article.
 - f. Qualified Professional Engineer: All designated-design submittals for seismic [and wind-load-restraint]calculations are to be signed and sealed by qualified professional engineer responsible for their preparation.
 - 2. Seismic-[and Wind-Load-]Restraint Detail Drawing:
 - a. Design Analysis: To support selection and arrangement of seismic[and wind] restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.

- c. Coordinate seismic restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply also with requirements in other Sections for equipment mounted outdoors.
- 3. Product Listing, Preapproval, and Evaluation Documentation: By [an evaluation service member of ICC-ES] [UL] [FM Approvals] [OSHPD] [an agency acceptable to authorities having jurisdiction], showing maximum ratings of restraint items and the basis for approval (tests or calculations).
- 4. All delegated-design submittals for seismic- and wind-restraint detail Drawings are to be signed and sealed by qualified professional engineer responsible for their preparation.
- 5. Design Calculations for Vibration Isolation Devices: Calculate static and dynamic loading due to equipment weight and operating forces required to select proper vibration isolators, and to design vibration isolation bases.
- 6. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and spring deflection changes. Include certification that riser system was examined for excessive stress and that none exists.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of vibration isolation [and wind-load reinforcement] device installation and seismic bracing for plumbing piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.
- B. Qualification Data: For [professional engineer] [and] [testing agency].
- C. Welding certificates.
- D. Air-Spring Mounting System Performance Certification: Include natural frequency, load, and damping test data[performed by an independent agency].
- E. Field quality-control reports:
- F. Seismic Qualification Data: Provide special certification for designated seismic systems as indicated in [ASCE/SEI 7-05,] [ASCE/SEI 7-10,] [ASCE/SEI 7-16,] Paragraph 13.2.2, "Special Certification Requirements for Designated Seismic Systems" for all Designated Seismic Systems identified as such on Drawings or in the Specifications.
 - 1. Provide equipment manufacturer's written certification for each designated active plumbing seismic device and system, stating that it will remain operable following the design earthquake. Certification must be based on requirements of ASCE/SEI 7 and AHRI 1270 (AHRI 1271), including shake table testing per ICC-ES AC156 or a similar nationally recognized testing standard procedure acceptable to authorities having jurisdiction[, or experience data as permitted by] [ASCE/SEI 7-05] [ASCE/SEI 7-10] [ASCE/SEI 7-16].
 - 2. Provide equipment manufacturer's written certification that components with hazardous contents maintain containment following the design earthquake by methods required in [ASCE/SEI 7-05] [ASCE/SEI 7-10] [ASCE/SEI 7-16].
 - 3. Submit evidence demonstrating compliance with these requirements for approval to authorities having jurisdiction after review and acceptance by a licensed professional engineer.
 - 4. The following plumbing systems and components are Designated Seismic Systems and require written special certification of seismic qualification by manufacturer:
 - a. <Insert list>.

- G. Wind-Force Performance Certification: Provide special certification for plumbing components subject to high wind exposure and impact damage and designated on Drawings or in the Specifications to require wind-force performance certification.
 - 1. Provide equipment manufacturer's written certification for each designated plumbing device, stating that it will remain in place and operable following the design wind event and comply with all requirements of authorities having jurisdiction.
 - 2. Certification must be based on ICC-ES or similar nationally recognized testing standard procedures acceptable to authorities having jurisdiction.
 - 3. The following plumbing systems and components require special certification for high wind performance. Written special certification of resistance to the effects of high wind force and impact damage must be provided by manufacturer:
 - a. <Insert list>.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For [air-spring isolators] [and] [restrained-air-spring isolators] to include in operation and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, be an NRTL as defined by OSHA in 29 CFR 1910.7, and be acceptable to authorities having jurisdiction.
- B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code Steel."
- C. Seismic-[and Wind-Load-]Restraint Device Load Ratings: Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by one or more of the following: [ICC-ES product listing] [UL product listing] [FM Approvals] [an evaluation service member of ICC-ES] [an agency acceptable to authorities having jurisdiction].

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 4000 "Quality Requirements," to design seismic [**and wind-load**]control system.
 - 1. Seismic[and Wind-Load] Performance: Equipment shall withstand the effects of earthquake motions[and high wind events] determined in accordance with [ASCE/SEI 7-05] [ASCE/SEI 7-10] [ASCE/SEI 7-16] <Insert requirement>.
- B. Seismic Design Calculations:
 - Perform calculations to obtain force information necessary to properly select seismicrestraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in [ASCE/SEI 7-05] [ASCE/SEI 7-10 including supplement No. 1] [ASCE/SEI 7-16] <Insert ASCE/SEI 7 edition or other seismic calculation method required by authorities having jurisdiction>. Where "ASCE/SEI 7" is used throughout this Section, it is to be understood that the edition referred to in this subparagraph is the edition intended as reference throughout the section text.

- a. Data indicated below to be determined by Delegated-Design Contractor must be obtained by Contractor and must be included in individual component submittal packages.
- b. Coordinate seismic design calculations with wind-load calculations for equipment mounted outdoors. Comply with requirements in other Sections in addition to those in this Section for equipment mounted outdoors.
- c. Building Occupancy Category: [I] [II] [III] [IV].
- d. Building Risk Category: [I] [II] [III] [IV].
- e. Building Site Classification: [A] [B] [C] [D] [E] [F].
- Calculation Factors, ASCE/SEI 7-16, Ch. 13 Seismic Design Requirements for Nonstructural Components: All section, paragraph, equation, and table numbers refer to ASCE/SEI 7-16 unless otherwise noted.
 - a. Horizontal Seismic Design Force F_p: Value is to be calculated by Delegated-Design Contractor using Equation 13.3-1. Factors below must be obtained for this calculation.
 - 1) S_{DS} = Spectral Acceleration: <**Insert value**>. Value applies to all components on Project.
 - 2) a_p = Component Amplification Factor: See Drawing Schedule for each component.
 - 3) I_p = Component Importance Factor: See Drawing Schedule for each component.
 - 4) W_p = Component Operating Weight: For each component. Obtain by Delegated-Design Contractor from each component submittal.
 - 5) R_p = Component Response Modification Factor: See Drawing Schedule for each component.
 - z = Height in Structure of Point of Attachment of Component for Base: Determine from Project Drawings for each component by Delegated-Design Contractor. For items at or below the base, "z" shall be taken as zero.
 - 7) h = Average Roof Height of Structure for Base: Determine from Project Drawings by Delegated-Design Contractor.
 - b. Vertical Seismic Design Force: Calculated by Delegated-Design Contractor using method explained in ASCE/SEI 7-16, Paragraph 13.3.1.2.
 - c. Seismic Relative Displacement D_{pl}: Calculated by Delegated-Design Contractor using methods explained in ASCE/SEI 7-16, Paragraph 13.3.2. Factors below must be obtained for this calculation:
 - D_p = Relative Seismic Displacement that Each Component Must Be Designed to Accommodate: Calculated by Delegated-Design Contractor in accordance with ASCE/SEI 7-16, Paragraph 13.3.2.
 - I_e = Structure Importance Factor: <Insert value>. Value applies to all components on Project.
 - 3) δ_{xA} = Deflection at Building Level x of Structure A: See Drawing Schedule for each component.
 - 4) δ_{yA} = Deflection at Building Level y of Structure A: See Drawing Schedule for each component.
 - 5) δ_{yB} = Deflection at Building Level y of Structure B: See Drawing Schedule for each component.
 - h_x = Height of Level x to which Upper Connection Point Is Attached: Determine for each component by Delegated-Design Contractor from Project Drawings and manufacturer's data.
 - 7) h_y = Height of Level y to which Upper Connection Point Is Attached: Determine for each component by Delegated-Design Contractor from Project Drawings and manufacturer's data.
 - 8) Δ_{aA} = Allowable Story Drift for Structure A: See Drawing Schedules for each component.

- 9) Δ_{aB} = Allowable Story Drift for Structure B: See Drawing Schedules for each component.
- 10) h_{sx} = Story Height Used in the Definition of Allowable Drift Δ_a : See Drawings Schedules for each component.
- d. Component Fundamental Period T_p: Calculated by Delegated-Design Contractor using methods explained in ASCE/SEI 7-16, Paragraph 13.3.3. Factors below must be obtained for this calculation:
 - W_p = Component Operating Weight: Determined by Contractor from Project Drawings and manufacturer's data.
 - 2) g = Gravitational Acceleration: [32.17 fps² (9.81 m/s²)] <Insert option>.
 - K_p = Combined Stiffness of the Component, Supports, and Attachments: Determined by delegated-design seismic engineer. < Insert value>.
- 3. Calculation Factors, ASCE/SEI 7-10, Ch. 13 Seismic Design Requirements for Nonstructural Components: All section, paragraph, equation, and table numbers refer to ASCE/SEI 7-10 unless otherwise noted.
 - a. Horizontal Seismic Design Force F_p: Calculated by Delegated-Design Contractor by ASCE/SEI 7-10, Equation 13.3-1. Factors below must be obtained for this calculation:
 - 1) S_{DS} = Spectral Acceleration: <**Insert value**>. Value applies to all components on Project.
 - 2) a_p = Component Amplification Factor: See Drawing Schedule for each component.
 - 3) I_p = Component Importance Factor: See Drawing Schedule for each component.
 - 4) W_p = Component Operating Weight: For each component. Obtain by Delegated-Design Contractor from equipment submittal.
 - 5) R_p = Component Response Modification Factor: See Drawing Schedule for each component.
 - 6) z = Height in Structure of Point of Attachment of Component for Base: Determined from Project Drawings for each component by Contractor. For items at or below the base, "z" shall be taken as zero.
 - 7) h = Average Roof Height of Structure for Base: Determine from Project Drawings by Delegated-Design Contractor.
 - b. Vertical Seismic Design Force: Calculate by Delegated- Design Contractor using method explained in ASCE/SEI 7-10, Paragraph 13.3.1.
 - c. Seismic Relative Displacement D_{pl}: Calculate by Delegated-Design Contractor using methods explained in ASCE/SEI 7-10, Paragraph 13.3.2. Factors below must be obtained for this calculation:
 - D_p = Relative Seismic Displacement that Each Component Must Be Designed to Accommodate: Calculate by Delegated-Design Contractor in accordance with ASCE/SEI 7-10, Paragraph 13.3.2.
 - 2) I_e = Structure Importance Factor: <**Insert value**>. Value applies to all components on Project.
 - 3) δ_{xA} = Deflection at Building Level x of Structure A: See Drawing Schedule for each component.
 - 4) δ_{yA} = Deflection at Building Level y of Structure A: See Drawing Schedule for each component.
 - 5) δ_{yB} = Deflection at Building Level y of Structure B: See Drawing Schedule for each component.
 - h_x = Height of Level x to which Upper Connection Point Is Attached: Determine for each component by Delegated-Design Contractor from Project Drawings and manufacturer's data;

- 7) h_y = Height of Level y to which Upper Connection Point Is Attached: Determine for each component by Delegated-Design Contractor from Project Drawings and manufacturer's data.
- 8) Δ_{aA} = Allowable Story Drift for Structure A: See Drawing Schedule for each component.
- 9) Δ_{aB} = Allowable Story Drift for Structure B: See Drawing Schedule for each component.
- 10) h_{sx} = Story Height Used in the Definition of the Allowable Drift Δ_a : See Schedule for each component.
- 4. Calculation Factors, ASCE/SEI 7-05, Ch. 13 Seismic Design Requirements for Nonstructural Components: All section, paragraph, equation, and table numbers refer to ASCE/SEI 7-05 unless otherwise noted.
 - a. Horizontal Seismic Design Force F_p: Calculated by Delegated-Design Contractor by ASCE/SEI 7-05, Equation 13.3-1. Factors below must be obtained for this calculation.
 - 1) S_{DS} = Spectral Acceleration: <**Insert value**>. Value applies to all components on the project.
 - 2) a_p = Component Amplification Factor: See Drawing Schedule for each component.
 - 3) I_p = Component Importance Factor: See Drawing Schedule for each component.
 - 4) W_p = Component Operating Weight: Obtain by Delegated-Design Contractor for each component from component submittal.
 - 5) R_p = Component Response Modification Factor: See Drawing Schedule for each component.
 - 6) z = Height in Structure of Point of Attachment of Component for the Base: Determine by Delegated-Design Contractor for each component from Project Drawings. For items at or below the base, "z" shall be taken as zero.
 - 7) h = Average Roof Height of Structure for the Base: Determine by Delegated-Design Contractor from Project Drawings.
 - b. Vertical Seismic Design Force: Calculated by Delegated-Design Contractor using method explained in ASCE/SEI 7-05, Paragraph 13.3.1.
 - c. Seismic Relative Displacement D_p: Calculated by Delegated-Design Contractor using methods explained in ASCE/SEI 7-05, Paragraph 13.3.2. Factors below must be obtained for this calculation:
 - 1) δ_{xA} = Deflection at Building Level x of Structure A: See Drawing Schedule for each component.
 - 2) δ_{yA} = Deflection at Building Level y of Structure A: See Drawing Schedule for each component.
 - 3) δ_{yB} = Deflection at Building Level y of Structure B: See Drawing Schedule for each component.
 - h_x = Height of Level x to which Upper Connection Point Is Attached: Determine for each component by Delegated-Design Contractor from Project Drawings and manufacturer's data.
 - 5) h_y = Height of Level y to which Upper Connection Point Is Attached: Determine for each component by Delegated-Design Contractor from Project Drawings and manufacturer's data.
 - 6) Δ_{aA} = Allowable Story Drift for Structure A: See Drawing Schedule for each component.
 - 7) Δ_{aB} = Allowable Story Drift for Structure B: See Drawing Schedule for each component.
 - 8) h_{sx} = Story Height Used in the Definition of the Allowable Drift Δ_a : See Drawing Schedule for each component.

- C. Wind-Load Design Calculations:
 - Perform calculations to obtain force information necessary to properly select wind-load-restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in [ASCE/SEI 7-05] [ASCE/SEI 7-10] [ASCE/SEI 7-16] <Insert ASCE/SEI 7 edition or other wind-force calculation method required by authorities having jurisdiction>. Where "ASCE/SEI 7" is used throughout this Section, it is to be understood that the edition referred to in this subparagraph is intended as referenced throughout the Section Text unless otherwise noted.
 - a. Data indicated below that are specific to individual pieces of equipment must be obtained by Contractor and must be included in individual component submittal packages.
 - b. Coordinate design wind-load calculations with seismic load calculations for equipment requiring both seismic and wind-load reinforcement. Comply with requirements in other Sections in addition to those in this Section for equipment mounted outdoors.
 - 2. Design wind pressure "p" for external sidewall-mounted equipment is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-16, Ch. 30. Perform calculations according to one of the following, as appropriate:
 - a. PART 1: Low-Rise Buildings.
 - b. PART 2: Low-Rise Buildings (Simplified).
 - c. PART 3: Buildings with "h" less than 60 feet (18.3 m).
 - d. PART 4: Buildings with "h" greater than 60 feet (18.3 m) and less than 160 feet (48.8 m).
 - e. PART 5: Open Buildings.
 - 3. Design wind pressure "p" for rooftop equipment is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-16, Ch. 30, PART 6: Building Appurtenances and Rooftop Structures and Equipment.
 - a. Risk Category: [I] [II] [III] [IV] [V].
 - b. h = Mean Roof Height: <**Insert value**>.
 - c. V = Basic Wind Speed: <**Insert value**>.
 - d. K_d = Wind Directionality Factor: <**Insert factor**>.
 - e. Exposure Category: [B] [C] [D].
 - f. K_{zt} = Topographic Factor: <**Insert factor**>.
 - g. K_e = Ground Elevation Factor: <**Insert factor**>.
 - h. K_z = Velocity Pressure Exposure Coefficient (Evaluated at Height z): <Insert coefficient>.
 - i. K_h = Velocity Pressure Exposure Coefficient (Evaluated at Height h): <**Insert** coefficient>.
 - j. q_z = Velocity Pressure: Value calculated by delegated wind-load design contractor using methods detailed in ASCE/SEI 7-16 Section 26 .10.1 or other source approved by authorities having jurisdiction.
 - k. q_h = Velocity Pressure: Value calculated by delegated wind-load design contractor using methods detailed in ASCE/SEI 7-16 Section 26 .10.1 or other source approved by authorities having jurisdiction.
 - I. G = Gust-Effect Factor: [0.85] <Insert factor>.
 - m. Enclosure Classification: <Insert classification>.
 - n. GC_{pi} = Internal Pressure Coefficient: <**Insert coefficient**>.
 - 4. Design wind pressure "p" for external sidewall-mounted equipment is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-10, Ch. 30. Perform calculations in accordance with one of the following, as appropriate:
 - a. PART 1: Low-Rise Buildings.
 - b. PART 2: Low-Rise Buildings (Simplified).
 - c. PART 3: Buildings with "h" greater than 60 feet (18.3 m).
 - d. PART 4: Buildings with "h" less than 160 feet (48.8 m).

- e. PART 5: Open Buildings.
- 5. Design wind pressure "p" for rooftop equipment is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-10, Ch. 30, PART 6: Building Appurtenances and Rooftop Structures and Equipment.
 - a. Risk Category: [I] [II] [III] [IV] [V].
 - b. h = Mean Roof Height: <**Insert value**>.
 - c. V = Basic Wind Speed: < Insert value>.
 - d. K_d = Wind Directionality Factor: <**Insert factor**>.
 - e. Exposure Category: [B] [C] [D].
 - f. K_{zt =} Topographic Factor: <**Insert factor**>.
 - g. K_z = Velocity Pressure Exposure Coefficient (Evaluated at Height z): <Insert coefficient>.
 - h. K_h = Velocity Pressure Exposure Coefficient (Evaluated at Height h): <**Insert** coefficient>.
 - i. q_z = Velocity Pressure at Height z: Value calculated by delegated wind-load design contractor using methods detailed in ASCE/SEI 7-10 Section 26 .10.1 or other source approved by authorities having jurisdiction.
 - j. q_h = Velocity Pressure at Height h: Value calculated by delegated wind-load design contractor using methods detailed in ASCE/SEI 7-10 Section 26 .10.1 or other source approved by authorities having jurisdiction.
 - k. G = Gust-Effect Factor: [0.85] < Insert factor>.
 - I. Enclosure Classification: <Insert classification>.
 - m. GC_{pi} = Internal Pressure Coefficient: <**Insert coefficient**>.
- 6. Design Wind Force "F" for rooftop equipment and external sidewall-mounted equipment such as louvers is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-05, Ch. 6.
 - a. I = Importance Factor: <Insert factor>.
 - b. h = Mean Roof Height: <**Insert value**>.
 - c. V = Basic Wind Speed: <Insert value>.
 - d. K_d = Wind Directionality Factor: <**Insert factor**>.
 - e. Exposure Category: [B] [C] [D].
 - f. K_{zt =} Topographic Factor: <**Insert factor**>.
 - g. K_z = Velocity Pressure Exposure Coefficient (Evaluated at Height z): <Insert coefficient>.
 - h. K_h = Velocity Pressure Exposure Coefficient (Evaluated at Height h): <Insert coefficient>.
 - i. q_z = Velocity Pressure at Height z: Value calculated by delegated wind-load design contractor using methods detailed in ASCE/SEI 7-05 Section 6.5.10 or other source approved by authorities having jurisdiction.
 - j. q_h = Velocity Pressure at Roof Height h: Value calculated by delegated wind-load design contractor using methods detailed in ASCE/SEI 7-05 Section 6.5.10 or other source approved by authorities having jurisdiction.
 - k. G = Gust-Effect Factor: [0.85] < Insert factor>.
 - I. GC_{pi}= Internal Pressure Coefficient: <**Insert coefficient**>.
 - m. GC_p = External pressure coefficient: <Insert coefficient>.
 - n. C_f = Force Coefficient: Value determined by delegated wind-load design Contractor from ASCE/SEI 7-05, Figures 6-21 through 6-23 or other source approved by authorities having jurisdiction.
 - A_f = Projected area normal to the wind: except where C_f is specified for the actual surface area. Value determined by delegated wind-load design contractor from equipment submittal or manufacturer.
- D. Consequential Damage: Provide additional seismic and wind-force restraints for suspended plumbing components or anchorage of floor, roof or wall mounted plumbing components as indicated in [ASCE/SEI 7-05] [ASCE/SEI 7-10] [ASCE/SEI 7-16] so that failure of a non-

essential or essential plumbing component will not cause the failure of any other essential architectural, mechanical or electrical building component.

- E. Fire/Smoke Resistance: Seismic-[and wind-load-]restraint devices that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL in accordance with ASTM E84 or UL 723, and be so labeled.
- F. Component Supports:
 - 1. Load Ratings, features, and applications of all reinforcement components must be based on testing standards of a nationally recognized testing agency.
 - 2. All component support attachments must comply with force and displacement resistance requirements of [ASCE/SEI 7-05 Section 13.6] [ASCE/SEI 7-10 Section 13.6] [ASCE/SEI 7-16 Section 13.6].

2.2 ELASTOMERIC ISOLATION PADS

- A. Elastomeric Isolation Pads: <Insert drawing designation>.
 - 1. <a>

 Couble click here to find, evaluate, and insert list of manufacturers and products.
 - 2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
 - 3. Size: Factory or field cut to match requirements of supported equipment.
 - 4. Pad Material: Oil and water resistant with elastomeric properties. Neoprene rubber, silicone rubber, or other elastomeric material.
 - 5. Surface Pattern: Smooth, ribbed, or waffle pattern.
 - 6. Infused nonwoven cotton or synthetic fibers.
 - 7. Load-bearing metal plates adhered to pads.
 - 8. Sandwich-Core Material: [Resilient] [and] [elastomeric] <Insert compound>.
 - a. Surface Pattern: Smooth, ribbed, or waffle pattern.
 - b. Infused nonwoven cotton or synthetic fibers.

2.3 ELASTOMERIC ISOLATION MOUNTS

- A. Double-Deflection, Elastomeric Isolation Mounts: <**Insert drawing designation**>.
 - 1. <a>

 <u><Double click here to find, evaluate, and insert list of manufacturers and products.></u>
 - 2. Mounting Plates:
 - a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded[with threaded studs or bolts].
 - b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
 - 3. Elastomeric Material: Molded, oil- and water-resistant neoprene rubber, silicone rubber, or other elastomeric material.

2.4 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

- A. Restrained Elastomeric Isolation Mounts: <**Insert drawing designation**>.
 - 1. <a>

 20 State of Comparison of Comparis
 - 2. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
 - a. Housing: Cast-ductile iron or welded steel.
 - b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.5 OPEN-SPRING ISOLATORS

- A. Freestanding, Laterally Stable, Open-Spring Isolators: <**Insert drawing designation**>.
 - 1. <<u>Double click here to find, evaluate, and insert list of manufacturers and products.</u>>
 - 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - 6. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psig (3447 kPa).
 - 7. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

2.6 HOUSED-SPRING ISOLATORS

- A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing: <**Insert** drawing designation>.
 - 1. <a>

 Couble click here to find, evaluate, and insert list of manufacturers and products.>
 - 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - 6. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.
 - a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig (3447 kPa).
 - b. Top housing with [attachment and leveling bolt] [threaded mounting holes and internal leveling device] [elastomeric pad].

2.7 RESTRAINED-SPRING ISOLATORS

- A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint: <**Insert** drawing designation>.
 - 1. <a>

 Ouble click here to find, evaluate, and insert list of manufacturers and products.>
 - 2. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
 - a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig (3447 kPa).
 - b. Top plate with [threaded mounting holes] [elastomeric pad].
 - c. Internal leveling bolt that acts as blocking during installation.
 - 3. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
 - 4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
2.8 HOUSED-RESTRAINED-SPRING ISOLATORS

- A. Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing: <**Insert drawing designation**>.
 - 1. < < >Double click here to find, evaluate, and insert list of manufacturers and products.>
 - 2. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with [adjustable] [non-adjustable] snubbers to limit vertical movement.
 - a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig (3447 kPa).
 - b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.
 - 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.9 PIPE-RISER RESILIENT SUPPORT

- A. All-Directional, Acoustical Pipe Anchor Consisting of Two Steel Tubes Separated by a Minimum 1/2-inch- (13-mm-) Thick Neoprene: <**Insert drawing designation**>.
 - 1. <a>

 2. Couble click here to find, evaluate, and insert list of manufacturers and products.
 - 2. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
 - 3. Maximum Load Per Support: 500 psig (3447 KPa) on isolation material providing equal isolation in all directions.

2.10 RESILIENT PIPE GUIDES

- A. Telescopic Arrangement of Two Steel Tubes or Post and Sleeve Arrangement Separated by a Minimum 1/2-inch- (13-mm-) Thick Neoprene: <**Insert drawing designation**>.
 - 1. <a>

 Couble click here to find, evaluate, and insert list of manufacturers and products.
 - 2. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.11 AIR-SPRING ISOLATORS

- A. Freestanding, Single or Multiple, Compressed-Air Bellows: <Insert drawing designation>.
 - 1. <a>

 Couble click here to find, evaluate, and insert list of manufacturers and products.
 - 2. Bellows Assembly: Upper and lower powder-coated steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows or similar elastomeric material.
 - 3. Maximum Natural Frequency: 3 Hz.
 - 4. Operating Pressure Range: 25 to 100 psig (172 to 690 kPa).
 - 5. Burst Pressure: At least three times manufacturer's published maximum operating pressure.
 - 6. Automatic leveling valve.

2.12 RESTRAINED-AIR-SPRING ISOLATORS

- A. Freestanding, Single or Multiple, Compressed-Air Bellows with Vertical-Limit Stop Restraint: <**Insert drawing designation**>.
 - 1. <a>

 Couble click here to find, evaluate, and insert list of manufacturers and products.

- 2. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
 - a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig (3447 kPa).
 - b. Top plate with [threaded mounting holes] [elastomeric pad].
 - c. Internal leveling bolt that acts as blocking during installation.
- 3. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
- 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
- 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
- 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- 7. Bellows Assembly: Upper and lower powder-coated steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows or similar elastomeric material.
- 8. Maximum Natural Frequency: [3 Hz] < Insert frequency>.
- 9. Operating Pressure Range: 25 to 100 psig (172 to 690 kPa).
- 10. Burst Pressure: At least three times manufacturer's published maximum operating pressure.
- 11. Automatic leveling valve.

2.13 ELASTOMERIC HANGERS

- A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods: < Insert drawing designation >.
 - 1. <a>

 Couble click here to find, evaluate, and insert list of manufacturers and products.
 - 2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
 - 3. Damping Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel-to-steel contact.

2.14 SPRING HANGERS

- A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression: <**Insert drawing designation**>.
 - 1. <a>

 Couble click here to find, evaluate, and insert list of manufacturers and products.>
 - 2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 - 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - 7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
 - 8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
 - 9. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

2.15 SNUBBERS

A. <a>

 A. <a>

 Couble click here to find, evaluate, and insert list of manufacturers and products.>

- B. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
 - Post-installed Concrete Anchor Bolts: Secure to concrete surface with post-installed concrete anchors. Anchors to be seismically prequalified in accordance with ACI 355.2 testing and designated in accordance with [ACI 318-08 Appendix D for 2009 IBC] [ACI 318-11 Appendix D for 2012 IBC] [ACI 318-14 Ch. 17 for 2015 or 2018 IBC]. Preset concrete inserts: Seismically prequalified in accordance with ICC-ES AC446 testing.
 - 2. Anchors in Masonry: Design in accordance with TMS 402.
 - 3. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
 - 4. Resilient Cushion: Maximum 1/4-inch (6-mm) air gap, and minimum 1/4 inch (6 mm) thick.

2.16 RESTRAINTS - RIGID TYPE

- A. < Double click here to find, evaluate, and insert list of manufacturers and products.>
- B. Description: Shop- or field-fabricated bracing assembly made of ANSI/AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe as per NFPA 13, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.17 **RESTRAINTS - CABLE TYPE**

- A. <a>

 Ouble click here to find, evaluate, and insert list of manufacturers and products.>
- B. Seismic-[and Wind-Load-]Restraint Cables: [ASTM A1023/A1023M galvanized or ASTM A603 galvanized-steel] [ASTM A492 stainless steel] cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for seismic restraining cable service; with fittings attached by means of poured socket, swaged socket or mechanical (Flemish eye) loop.
- C. Restraint cable assembly and cable fittings must comply with ASCE/SEI 19. All cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge type end fittings do not comply and are unacceptable.

2.18 **RESTRAINT ACCESSORIES**

- A. <a>

 Ouble click here to find, evaluate, and insert list of manufacturers and products.>

- B. Hanger-Rod Stiffener: [Steel tube or steel slotted-support-system sleeve with internally bolted connections] [Reinforcing steel angle clamped] to hanger rod. Non-metallic stiffeners are unacceptable.
- C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to [rigid channel bracings] [and] [restraint cables].
- D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.19 POST-INSTALLED CONCRETE ANCHORS

- A. Mechanical Anchor Bolts:
 - 1. <a>

 Couble click here to find, evaluate, and insert list of manufacturers and products.
 - 2. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.
- B. Adhesive Anchor Bolts:
 - 1. <a>

 Couble click here to find, evaluate, and insert list of manufacturers and products.
 - 2. Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.
- C. Provide post-installed concrete anchors that have been prequalified for use in seismic applications. Post-installed concrete anchors must comply with all requirements of [ASCE/SEI 7-05, Ch. 13] [ASCE/SEI 7-10, Ch. 13] [ASCE/SEI 7-16, Ch. 13].
 - 1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
 - 2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.
- D. Expansion-type anchor bolts are not permitted for equipment in excess of 10 hp (7.46 kW), which is not vibration isolated.
 - 1. Undercut expansion anchors are permitted.

2.20 CONCRETE INSERTS

- A. <a>

 Ouble click here to find, evaluate, and insert list of manufacturers and products.>

- B. Provide preset concrete inserts, which are seismically prequalified in accordance with ICC-ES AC466 testing.
- C. Comply with ANSI/MSS 58.

2.21 VIBRATION ISOLATION EQUIPMENT BASES

- A. <a>

 A. <a>

 Couble click here to find, evaluate, and insert list of manufacturers and products.>
- B. Steel Rails: Factory-fabricated, welded, structural-steel rails.
 - Design Requirements: Lowest possible mounting height with not less than 1-inch (25mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide rails.
 - a. Include supports for suction and discharge elbows for pumps.
 - 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Rails shall have shape to accommodate supported equipment.
 - 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

- C. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.
 - Design Requirements: Lowest possible mounting height with not less than 1-inch (25mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - a. Include supports for suction and discharge elbows for pumps.
 - 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases shall have shape to accommodate supported equipment.
 - 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
- D. Concrete Inertia Base: [Factory-fabricated] [or] [field-fabricated], welded, structural-steel bases and rails ready for placement of cast-in-place concrete.
 - Design Requirements: Lowest possible mounting height with not less than 1-inch (25-mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - a. Include supports for suction and discharge elbows for pumps.
 - 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases shall have shape to accommodate supported equipment.
 - 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
 - 4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation[, wind-load control,] and seismic control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by [an evaluation service member of ICC-ES] [OSHPD] [an agency acceptable to authorities having jurisdiction].
- B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength is adequate to carry static[, wind load,] and seismic load within specified loading limits.

3.3 INSTALLATION OF VIBRATION CONTROL[, WIND-LOAD CONTROL,] AND SEISMIC-RESTRAINT DEVICES

- A. Provide vibration-control devices for systems and equipment where indicated in Equipment Schedules or Vibration-Control Device Schedules, where indicated on Drawings, or where the Specifications indicate they are to be installed on specific equipment and systems.
- B. Provide seismic-restraint [and wind-load control] devices for systems and equipment where indicated in Equipment Schedules or Seismic-Restraint Devices Schedules, where indicated on Drawings, where the Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.
- C. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 03 3000 "Cast-in-Place Concrete."
- D. Installation of vibration isolators[, wind-load restraints,] and seismic restraints must not cause any stresses, misalignment, or change of position of equipment or piping.
- E. Comply with requirements in Section 07 7200 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
- F. Equipment Restraints:
 - 1. Install snubbers on plumbing equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
 - 2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
 - 3. Install seismic-restraint[and wind-load-restraint] devices using methods approved by [an evaluation service member of ICC-ES] [OSHPD] [an agency acceptable to authorities having jurisdiction] that provides required submittals for component.
- G. Piping Restraints:
 - 1. Comply with requirements in MSS SP-127.
 - 2. Space lateral supports a maximum of [40 feet (12 m)] <Insert dimension> o.c., and longitudinal supports a maximum of [80 feet (24 m)] <Insert dimension> o.c.
 - 3. Brace a change of direction longer than 12 feet (3.7 m).
- H. Install seismic-[**and wind-load-**]restraint cables so they do not bend across edges of adjacent equipment or building structure.
- I. Install seismic-[and wind-load-]restraint devices using methods approved by [an evaluation service member of ICC-ES] [OSHPD] [an agency acceptable to authorities having jurisdiction] that provides required submittals for component.
- J. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- K. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- L. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

- M. Post-Installed Concrete Anchors:
 - Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify Project structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 3. Mechanical-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - 4. Adhesive-Type Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 - 5. Set anchors to manufacturer's recommended torque, using a torque wrench.
 - 6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.4 INSTALLATION OF AIR-SPRING ISOLATORS

- A. Independent Isolator Installation:
 - 1. Install automatic leveling valve into each air isolator.
 - 2. Inflate each isolator to [height] [and] [pressure] specified on Drawings.
- B. Pressure-Regulated Isolator Installation:
 - 1. Coordinate the constant pressure-regulated air supply to air springs with the requirements for piping and connections specified in Section 22 1513 "General-Service Compressed-Air Piping."
 - 2. Connect all pressure regulators to a single dry, filtered [facility] [constant] air supply.
 - 3. Inflate isolators to [height] [and] [or] [pressure] specified on Drawings.

3.5 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Provide flexible connections in piping systems where they cross structural seismic joints and other point where differential movement may occur. Provide adequate flexibility to accommodate differential movement as determined in accordance with ASCE/SEI 7. Comply with requirements in Section 22 1116 "Domestic Water Piping" and Section 22 1119 "Domestic Water Piping Specialties" for piping flexible connections.

3.6 INSTALLATION OF VIBRATION ISOLATION EQUIPMENT BASES

- A. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 03 3000 "Cast-in-Place Concrete."
- B. Coordinate dimensions of steel equipment rails, bases, and concrete inertia bases, with requirements of isolated equipment specified in this and other Sections. Where dimensions of bases are indicated on Drawings, they may require adjustment to accommodate actual isolated equipment.

3.7 ADJUSTING

A. Adjust isolators after system is at operating weight.

B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

3.8 FIELD QUALITY CONTROL

- A. Testing Agency: [**Owner will engage**] [**Engage**] a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Tests and Inspections:
 - 1. Perform tests and inspections[with the assistance of a factory-authorized service representative].
 - 2. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 - 3. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
 - 4. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 - 5. Test at least [four] <Insert number> of each type and size of installed anchors and fasteners selected by Architect.
 - 6. Test to 90 percent of rated proof load of device.
 - 7. Measure isolator restraint clearance.
 - 8. Measure isolator deflection.
 - 9. Verify snubber minimum clearances.
 - 10. Test and adjust restrained-air-spring isolator controls and safeties.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Units will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports.

END OF SECTION 22 0548

SECTION 22 0553 IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 **RELATED DOCUMENTS**

Α. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- Α. Section Includes:
 - 1. Equipment labels.
 - Warning signs and labels. 2.
 - Pipe labels. 3.
 - 4. Valve tags.
 - 5. Warning tags.

1.3 SUBMITTALS

Α. Product Data: For each type of product indicated.

1.4 COORDINATION

- Α. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- В. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- Α. Plastic Labels for Equipment:
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
 - Letter Color: White. 2.
 - 3. Background Color: Black.
 - Maximum Temperature: Able to withstand temperatures up to 160 deg F. 4.
 - Minimum Label Size: Length and width vary for required label content, but not less 5. than 2-1/2 by 3/4 inch.
 - 6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

Project No. 121505

Section 22 0553 - 1

- Fasteners: Stainless-steel rivets or self-tapping screws. 7.
- Adhesive: Contact-type permanent adhesive, compatible with label and with 8. substrate.

- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: White.
- C. Background Color: Black.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches.

2.4 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
 - 1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Fasteners: Brass wire-link or beaded chain; or S-hook.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - 1. Valve-tag schedule shall be included in operation and maintenance data.

2.5 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
 - 1. Size: 3 by 5-1/4 inches minimum.
 - 2. Fasteners: Brass grommet and wire.
 - 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 - 4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

- A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.

- 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
- 4. At access doors, manholes, and similar access points that permit view of concealed piping.
- 5. Near major equipment items and other points of origination and termination.
- 6. Spaced at maximum intervals of 25 feet along each run. Reduce intervals to 10 feet in areas of congested piping and equipment.
- 7. Identification of potable and non-potable water.
 - a. In all buildings where two or more water distribution systems, one potable water and the other non-potable water, are installed, each system shall be identified either by color marking or metal tags as required by ASME A13.1. Reclaimed water systems shall be identified using color coded Pantone Purple 522C and marked with the statement "NONPOTABLE WATER - NOT FOR HUMAN CONSUMPTION".
- B. Pipe Label Color: Refer to ASME (ANSI) Standard A13.1-2007.

3.4 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
 - 1. Valve-Tag Size and Shape: Brass valve tag, 2 inches, round, with stamped or engraved lettering.

3.5 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF DOCUMENT 22 0553

SECTION 22 0700 PLUMBING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Insulation Materials:
 - a. Flexible elastomeric.
 - b. Mineral fiber.
 - 2. Adhesives.
 - 3. Sealants.
 - 4. Field-applied jackets.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).
- B. LEED Submittal:
 - 1. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
- C. Shop Drawings:
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail attachment and covering of heat tracing inside insulation.
 - 3. Detail insulation application at pipe expansion joints for each type of insulation.
 - 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 5. Detail removable insulation at piping specialties, equipment connections, and access panels.
 - 6. Detail application of field-applied jackets.
 - 7. Detail application at linkages of control devices.
 - 8. Detail field application for each equipment type.
- D. Qualification Data: For qualified Installer.

Project No. 121505 Plumbing Insulation Section 22 0700 - 1

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smokedeveloped index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smokedeveloped index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application and equipment Installer for equipment insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
 - 1. Products: Subject to compliance with requirements, provide products by one of the following:
 - a. Aeroflex USA Inc.; Aerocel.
 - b. Armacell LLC; AP Armaflex.
 - c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.
- F. Mineral-Fiber, Preformed Pipe Insulation:
 - 1. Products: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; Micro-Lok.
 - b. Knauf Insulation; 1000(Pipe Insulation.
 - c. Owens Corning; Fiberglas Pipe Insulation.

2.2 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 1. Products: Subject to compliance with requirements, provide products by one of the following:
 - a. Aeroflex USA Inc.; Aeroseal.
 - b. Armacell LCC; 520 Adhesive.
 - c. Foster Products Corporation, H. B. Fuller Company; 85-75.
 - d. RBX Corporation; Rubatex Contact Adhesive.
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Products: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Products, Division of ITW; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
 - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
 - d. Marathon Industries, Inc.; 225.
 - e. Mon-Eco Industries, Inc.; 22-25.
- D. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

- 1. Products: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Products, Division of ITW; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
 - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
 - d. Marathon Industries, Inc.; 225.
 - e. Mon-Eco Industries, Inc.; 22-25.
- E. PVC Jacket Adhesive: Compatible with PVC jacket.
 - 1. Products: Subject to compliance with requirements, provide products by one of the following:
 - a. Dow Chemical Company (The); 739, Dow Silicone.
 - b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
 - c. P.I.C. Plastics, Inc.; Welding Adhesive.
 - d. Speedline Corporation; Speedline Vinyl Adhesive.

2.3 SEALANTS

- A. Joint Sealants:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2. Permanently flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 100 to plus 300 deg F.
 - 4. Color: White or gray.
- B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
 - 1. Products: Subject to compliance with requirements, provide products by one of the following:

a. Childers Products, Division of ITW; CP-76.

- 2. Materials shall be compatible with insulation materials, jackets, and substrates.
- 3. Fire- and water-resistant, flexible, elastomeric sealant.
- 4. Service Temperature Range: Minus 40 to plus 250 deg F.
- 5. Color: White.

2.4 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 - 1. Products: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; Zeston.
 - b. P.I.C. Plastics, Inc.; FG Series.

Project No. 121505 Plumbing Insulation Section 22 0700 - 4

- c. Proto PVC Corporation; LoSmoke.
- d. Speedline Corporation; SmokeSafe.
- 2. Adhesive: As recommended by jacket material manufacturer.
- 3. Color: White.
- 4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
- C. Metal Jacket:
 - 1. Products: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Products, Division of ITW; Metal Jacketing Systems.
 - b. PABCO Metals Corporation; Surefit.
 - c. RPR Products, Inc.; Insul-Mate.
 - 2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.
 - a. Factory cut and rolled to size.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
 - d. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
- D. Underground Direct-Buried Jacket: 125-mil- thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.
 - 1. Products: Subject to compliance with requirements, provide products by one of the following:
 - a. Pittsburgh Corning Corporation; Pittwrap.
 - b. Polyguard; Insulrap No Torch 125.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

Project No. 121505 Plumbing Insulation Section 22 0700 - 5

- 1. Verify that systems and equipment to be insulated have been tested and are free of defects.
- 2. Verify that surfaces to be insulated are clean and dry.
- 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 - 1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
 - 2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above ambient services, do not install insulation to the following:
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.
 - 4. Manholes.
 - 5. Handholes.
 - 6. Cleanouts.

Project No. 121505 Plumbing Insulation Section 22 0700 - 7

3.4 **PENETRATIONS**

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
 - 1. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 - 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
 - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 - 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. But each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 - 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 - 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap

adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.

- 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
- 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
- 8. For services not specified to receive a field-applied jacket except for flexible elastomeric install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
- 9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

3.6 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

- A. Seal longitudinal seams and end joints with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
 - 1. Install pipe insulation to outer diameter of pipe flange.
 - 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 - 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
 - 4. Secure insulation to flanges and seal seams with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
 - 1. Install mitered sections of pipe insulation.

Project No. 121505 Plumbing Insulation Section 22 0700 - 9

- 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
 - 1. Install preformed valve covers manufactured of same material as pipe insulation when available.
 - 2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - 3. Install insulation to flanges as specified for flange insulation application.
 - 4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 MINERAL-FIBER INSULATION INSTALLATION

- A. Insulation Installation on Straight Pipes and Tubes:
 - 1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 - 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 - 3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
 - 4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- B. Insulation Installation on Pipe Flanges:
 - 1. Install preformed pipe insulation to outer diameter of pipe flange.
 - 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 - 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
 - 4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.
- C. Insulation Installation on Pipe Fittings and Elbows:
 - 1. Install preformed sections of same material as straight segments of pipe insulation when available.

- 2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.
- D. Insulation Installation on Valves and Pipe Specialties:
 - 1. Install preformed sections of same material as straight segments of pipe insulation when available.
 - 2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
 - 3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - 4. Install insulation to flanges as specified for flange insulation application.

3.8 FINISHES

- A. Equipment and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.
 - 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

3.9 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

3.10 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Hot and Recirculated Hot Water:
 - 1. NPS 1-1/2 and Smaller: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
 - 2. NPS 2 and Larger: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 1/2 inch thick.

- B. Stormwater and Overflow:
 - 1. All Pipe Sizes: Insulation shall begin at the base of the roof drain and include all horizontal piping and elbows at changes in direction from the horizontal to the vertical and shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- C. Roof Drain and Overflow Drain Bodies:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- D. Condensate and Equipment Drain Water below 60 Deg F and Floor drain bodies and traps receiving condensate for the length of the system from the p-trap of the drain:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 3/4 inch thick.
- E. Condensate Force Main System:
 - 1. All Pipe Sizes: Installation shall be the following:
 - a. Flexible Elastomeric: ³/₄ inch thick.

3.11 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Domestic Water Piping:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 2 inch thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inch thick.
- B. Domestic Hot and Recirculated Hot Water:
 - 1. NPS 2 inches and smaller: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 2 inch thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inch thick.

3.12 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Exposed:
 - 1. None.
 - 2. PVC: 20 mils thick.

3.13 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Exposed:
 - 1. Aluminum, Smooth: 0.016 inch thick.

3.14 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF DOCUMENT 22 0700

SECTION 22 0800 COMMISSIONING OF PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
- B. General: The Owner will select a commissioning agency (herein referred to as the CxA) and pay for the services of the commissioning Agency for system and equipment performance verification.
- C. Definition of Terms:
 - a. "Contractor" shall refer to the General Contractor

1.2 SUMMARY

A. Section includes commissioning process requirements for Plumbing systems, assemblies, and equipment.

1.3 **DEFINITIONS**

- A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
- B. CxA: Commissioning Authority.
- C. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.4 ALLOWANCES

A. Labor, instrumentation, tools, and equipment costs for technicians for the performance of commissioning testing are covered by the "Schedule of Allowances" Article in Division 01 Section "Allowances."

1.5 UNIT PRICES

A. Commissioning testing allowance may be adjusted up or down by the "List of Unit Prices" Article in Division 01 Section "Unit Prices" when actual man-hours are computed at the end of commissioning testing.

1.6 CONTRACTOR'S RESPONSIBILITIES

- A. Perform commissioning tests at the direction of the CxA.
- B. Attend construction phase controls coordination meeting.
- C. Attend testing, adjusting, and balancing review and coordination meeting.

- D. Participate in Plumbing systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.
- E. Provide information requested by the CxA for final commissioning documentation.
- F. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.7 CxA'S RESPONSIBILITIES

- A. Provide Project-specific construction checklists and commissioning process test procedures for actual Plumbing systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.
- B. Direct commissioning testing.
- C. Verify testing, adjusting, and balancing of Work are complete.
- D. Provide test data, inspection reports, and certificates in Systems Manual.

1.8 COMMISSIONING DOCUMENTATION

- A. Provide the following information to the CxA for inclusion in the commissioning plan:
 - 1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
 - 2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
 - 3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for Plumbing systems, assemblies, equipment, and components to be verified and tested.
 - 4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
 - 5. Certificate of readiness certifying that Plumbing systems, subsystems, equipment, and associated controls are ready for testing.
 - 6. Test and inspection reports and certificates.
 - 7. Corrective action documents.
 - 8. Verification of testing, adjusting, and balancing reports.

1.9 SUBMITTALS

- A. Certificates of readiness.
- B. Certificates of completion of installation, prestart, and startup activities.

PART 2 - PRODUCTS (Not Used)

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 121505 Commissioning of Plumbing Section 22 0800 - 2

PART 3 - EXECUTION

3.1 TESTING PREPARATION

- A. Certify that Plumbing systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- C. Inspect and verify the position of each device and interlock identified on checklists.
- D. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- E. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.2 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- B. Scope of plumbing testing shall include plumbing systems as indicated below:
 - 1. Refer to Section 01 9113 for Scope of Plumbing Systems testing and for equipment strategies and sampling requirement functional performance test requirements.
- C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions.
- D. The CxA along with the Plumbing Subcontractor, shall prepare detailed testing plans, procedures, and checklists for plumbing systems, subsystems, and equipment to be commissioned.
- E. Tests will be performed using design conditions whenever possible. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions.
- F. The CxA may direct that set points be altered when simulating conditions is not practical.
- G. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- H. If tests cannot be completed because of a deficiency outside the scope of the plumbing system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- I. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.3 PLUMBING SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

- A. Water Heating Testing and Acceptance Procedures: Testing requirements are specified in Division 22 Sections. Provide submittals, test data, inspector record, and water heater certifications to the CxA.
- B. Plumbing Control System Testing: Field testing plans and testing requirements are specified in Division 22 Sections and Sequence of Operations indicated in/or the construction documents. Assist the CxA with preparation of testing plans.
- C. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in Division 22 piping Sections. Plumbing Subcontractor shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Plan shall include the following:
 - Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.
 - 2. Description of equipment for flushing operations.
 - 3. Minimum flushing water velocity.
 - 4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.
- D. Energy Supply System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of gas and hot-water systems and equipment at the direction of the CxA. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.

3.4 NON-CONFORMANCE

- A. The CxA will record the results of the Functional Performance Tests. All deficiencies, nonconformance issues, or test failures will be noted and reported to the Contractors in a deficiency list or in a punch-list format.
- B. Corrections of minor deficiencies identified may be made during the tests at the discretion of the CxA. In such cases the deficiency and resolution will be documented on the procedure form.
- C. Every effort will be made to expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the procedures. However, the CxA will not be pressured into overlooking deficient work or loosening acceptance criteria to satisfy scheduling or cost issues, unless there is an overriding reason to do so at the request of the Owners Representative.
- D. Re-Testing:
 - 1. If a Functional Performance Test fails, corrections shall be made to the deficient equipment or systems by the Contractors. The systems will be re-tested until they pass the Tests.

- 2. The time/cost for the CxA to perform any re-testing required because of improper set up of the systems by the contractors or failed functional or performance tests will be back-charged to the Contractor (who may choose to recover costs from the party responsible for executing faulty equipment start-up/checkout and associated checklists). This includes instances where a specific item was overlooked in the equipment start-up and checkout procedures, reported to have been successfully completed, but determined during Functional Performance testing to be faulty.
- 3. Any required re-testing by any contractor, sub-contractor, or vendor shall not be considered a justified reason for a claim of delay or for a time extension by the Contractor.

3.5 Deficiencies and Retesting

- A. The CxA documents the results of each test. (Corrections of minor installation or sequence of operation deficiencies are made during tests at the discretion of CxA.)
- B. Deficiencies/non-conformance issues not corrected during testing are reported to the Contractors for corrective action. Upon completion, a request is made by the Contractors to CxA for retest.

END OF DOCUMENT 22 0800

Chiller System Including: GWH-1,GWH-2, RP-1 AND RP-2

1. Participants Party	Participation
Party filling out this form and witnessing testing _	
Dates of tests	

2. Overview

In general, the Functional Performance Testing of the Boiler systems will include the following:

- Review all SVCs for boilers, and associated pumps
- Testing of Fuel Systems primary and backup

3. Prerequisite Checklist

- 1) The following have been started up and startup reports and system verification checklists (SVC's) submitted and approved ready for functional testing:
 - a) ____ Boilers
 - b) ____ Heating water piping and valves
 - c) ____ Heating water pumps
 - d) _____ Variable speed drives
- All control system functions for this and all interlocking systems are programmed and operable per contract documents, including final setpoints and schedules and with debugging, loop tuning and sensor and device calibrations completed.

Controls Contractor Signature or Verbal Date

- 3) ___ Piping system flushing complete and required report approved.
- 4) ____ Water treatment system complete and operational.
- 5) ____ Test and balance (TAB) complete and approved for the hydronic system.
- 6) ____ These functional test procedures reviewed and approved by installing contractor.
- 7) ____ Safeties and operating ranges reviewed.
- 8) ____ Sufficient clearance around equipment for servicing.
- 9) **Packaged Control Program Review.** Review the packaged control program(s) for this equipment. Parameters, setpoints and logic sequences appear to follow the specified written sequences.
- 10) ___ Record made of All Values for Current Setpoints (SPt), Control Parameters, Limits, Delays, Lockouts, Schedules, Etc. Changed to Accomodate Testing:

Parameter	Pre-Test Val- ues	Returned to Pre-Test Values √
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Parameter	Pre-Test Val- ues	Returned to Pre-Test Values √
Space Temp. Setpts		
Boiler enable OSAT setpoint		
Capacity (%) on lead boiler when lag boiler will start		
Time delay between stages		
Setpoint range for boilers		
Differential pressure setpoint		
Supply temp. reset schedule:	OSAT/ HWST	

General Conditions of Test and Seasonal Testing

The primary testing will occur during typical summer weather with minimal heating loads. Because the boiler will be operated year-round, the trends described in the testing procedures will be repeated during colder weather to ensure that the boilers are functioning properly in peak heating season.

False Loading. Be prepared to raise the space temperature setpoints to cause a real load on the heating system.

<u>Trending During Testing.</u> Prior to beginning testing, set up the following trends:

- 1) <u>Secondary Pumping, Trend at 5 minute intervals during testing:</u>
 - a) ____SHWP-1 speed
 - b) ____SHWP-2 speed
 - c) ____HW-Differential Pressure setpoint
 - d) ____HW-Differential Pressure
 - e) _____Avg Heating coil valve positions for terminal units
 - f) ____Heating water flow (HW-F).
- 2) <u>Hot Water Supply Temperature (HWS-T) Control.</u> Trend the HWS-T and OSAT at 5 minute intervals during the testing to verify constancy of HWS-T.

4. <u>Testing Procedures and Record</u>

To	at Stan	Toot Suo	Bomarka
Te	si siep		Remains
1) a	Staging Up During OSAT < 65F, manually shut OFF boilers and keep pumps running on man- ual to lower boiler water temperature to < 120F		
b. c.	With the boilers OFF, and boiler water temperature < 120F, overwrite the OSAT to be 66F and turn all systems to auto. Overwrite the OSAT to be 64F.	b	b. Boilers and all pumps should remain OFF.
		C	c. A secondary pump should start. After [] minutes delay, combustion supply fan, lead hot water pump and boiler start.
2)	Observe the HWS-T command to the boilers. Release the overwritten OSAT to be actual.		The command should be between 120F and 180F.
3)	Increase building load, as necessary, us- ing methods below (list). Lower the delay time between all stages to 3 minutes. Observe the staging of the boilers.		When the lead boiler reaches [%] (68%), the lag boiler starts. (HWS-T) is [F] & the return (HWR- T) is [F].
4)	Continue observing during staging. In- crease load to require lead and lag boilers to stage on until all boilers are firing.		Lead and lag boilers fire together, shar- ing load. (HWS-T) is [F] & the return (HWR- T) is [F].
5)	Staging Down. Remove all false loading to cause no call for heating.		Lag boilers stage off in reverse se- quence.
6)	Continue dropping the load or overwrite the HWS-T to be just high enough for the loop to be satisfied and no need for boil- ers.		When the HWS-T setpoint drops to 120F [F] for 3 minutes [], the lead boiler and primary pump drop OFF []
7)	Return the systems to normal, keeping the delay time at 3 minutes. Let boilers start. Overwrite the OSAT to be 67F and the HWS-T to be 5F greater than the cur- rent setpoint ofF.		After minutes [], all boilers shut OFF.
8)	HWST Reset. Overwrite the OSAT to be 15F, 25F, 40F; 65F. For each, record the HWS-T setpoint command.		All values should fall within 2F of the re- set line.

Test Step	Test Suc-	Remarks
9) Trend Log. Trend (not during testing) the OSAT, the HWS-T, HWS-T setpoint and the HWS-T minus HWS-T setpoint (the variance from setpoint), at 15 minute intervals from Thursday noon to Saturday noon.		All the (HWS-T minus HWS-T setpoint) values should be + or - 2F. Largest undershoot: [F]. Largest overshoot [F]. Number of values out of desired range (+/-2F): [data points] out of [] total points = [%] outside specified range.
10) Loop DP Control via Trending. Observe the Secondary Pumping trend logs per- formed during testing, specified in the General Conditions of Test section above		The running secondary pump ramps up in speed to maintain the loop DP setpoint farthest from setpoint. Observe that overshoot or undershoot of the loop differential pressure (DP) is with- in +/- 10% of the setpoint magnitude. Greatest undershoot: [psi =%]. Greatest overshoot: [psi =%]. Number of values out of desired range (+/-10%): [data points] out of [] total points = [%] outside specified range.

Test Step	Test Suc- cess (Y/N)	Remarks
11) Variable Speed Drive (VFD) on Second- ary hot water pump SHWP-1.		Motor manufacturer's recommended speed low limit = [% of max.].
 Carefully go over prefunctional check- list and programming record and iden- tify anomalies. Record the low limits. 	a	 a. Low limit setting in drive: [Hz, rpm =% of maximum]. Provide reasons for low limit not being at motor mfr's low limit.
		Also review any BAS software low limit- ing parameters. Verify that they are not unnecessarily preventing pumps to mod- ulate down to their safe minimum.
 b. With only one boiler running and other boilers manually OFF, reduce all heat- ing load or manually lower pump and remote differential pressure setpoints. See how low VFD will go. (This could be done during the Staging Down pro- cedures above.) 	b	 b. Lowest speed drive will go: [Hz, rpm]. Is this within 3 Hz of the low limit setting (or within a range equal to 5% of maxi- mum speed)? Is pump and remote dP SP maintained without hunting?
 c. Call for moderate heating or increase differential pressure setpoints. d. Call for maximum cooling or increase 	C	 c. Does VFD motor ramp up accordingly in a reasonable time? Is pump and remote dP SPt maintained without hunting? (This is verified in Procedure 20.)
differential pressure setpoints (keep- ing only 1 boiler ON).	d.	 d. Does VFD motor ramp to full speed in a reasonable time? Is pump and remote dP SPt maintained
e. Switch VFD into bypass operation, if feature available.		without hunting? (This is verified in Pro- cedure 20.)
	e	e. Verify that pump works in bypass mode.
12) Repeat Test 11 with each secondary		
 13) Staging Up of Secondary Pumps (via Trending.) Observe the Secondary Pumping trend logs performed during testing, specified in the General Conditions of Test section above. 		From the trends, with only one secondary pump ON, when the flow at HW-F ex- ceeds the rated gpm, of one pump [gpm;rpm or Hz], forminutes [], the first lag pump starts and both equalize in rpm or Hz [,].

Test Step	Test Suc- cess (Y/N)	Remarks
 14) Staging Down of Secondary Pumps (via Trending.) Observe the Secondary Pumping trend logs performed during testing, specified in the General Conditions of Test section above. 		With two secondary pumps ON, when the flow at HW-F is less than the rated gpm of both ON pumps, [] gpm; rpm or Hz], bygpm [], forminutes [], the last lag pump stops.
15) With each boiler at a time acting as lead ON, manually shut it OFF.	B-1 B-2 B-3	Lag boiler shall start and an alarm is generated in the BAS.
16) With each boiler at a time acting as lead ON, manually shut its pump OFF.	B-1 B-2 B-3	Lag boiler and pump shall start and an alarm is generated in the BAS.
17) With boilers in auto., shut OFF one of the ON secondary HW pumps.		The lag secondary pump is started and an alarm is generated in the BAS.
18) High limit. For each boiler when ON, low- er the high limit setting to the current wa- ter temperature to initiate an alarm and shutdown. Manually reset.	B-1 B-2 B-3	Boiler burners shut OFF and an alarm is generated in the BAS
19) Fuel system safety. For each boiler, when ON, jump or remove wires or close gas valve, as appropriate, to simulate an unsafe gas condition.	B-1 B-2 B-3	Boiler shuts OFF and an alarm is gener- ated in BAS.
20) Flame safety controls. For each boiler, when ON, demonstrate the function of the flame safety controls by simulating an alarm condition.	B-1 B-2 B-3	Boiler shuts OFF and an alarm is gener- ated in BAS.
21) Lift lever of each pressure relief valve.	B-1 B-2 B-3	Each releases water.
22) Return all changed control parameters and conditions to their pre-test values		
MONITORING AND TREND LOGGING. Monitoring via BAS trend logs are required per General Test Conditions and test Procedures. Attach representative graphs or columnar data and explanatory analysis to this test report. Columnar and electronic data shall have time in the left column and 4 to 6 columns of different parameters to the right. All abbreviations shall have definitions provided and all setpoints and schedules for each parameter shall be attached.

**<u>Abbreviations:</u> HWS-T = hot water supply temperature to the building, SPt = setpoint, BAS = building automation system.

A summary of deficiencies identified during testing is attached

-- END OF TEST --

SECTION 22 1113 FACILITY FUEL OIL PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes fuel oil distribution systems and the following:
 - 1. Pipes, tubes, and fittings.
 - 2. Piping and tubing joining materials.
 - 3. Piping specialties.
 - 4. Valves.
 - 5. FRP fuel-oil USTs.
 - 6. Fuel-oil AST accessories.
 - 7. Fuel-oil UST accessories.
 - 8. Fuel-oil storage tank piping specialties.
 - 9. Fuel-oil storage tank pumps.
 - 10. Fuel-transfer pumps.
 - 11. Fuel maintenance system.
 - 12. Liquid-level gage system.
 - 13. Leak-detection and monitoring system.
 - 14. Concrete bases.

1.3 **DEFINITIONS**

- A. AST: Aboveground storage tank.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- E. FPM: Vinylidene fluoride-hexafluoropropylene copolymer rubber.
- F. FRP: Glass-fiber-reinforced plastic.
- G. UST: Underground storage tank.

1.4 **PERFORMANCE REQUIREMENTS**

A. Maximum Operating-Pressure Ratings: 3-psig fuel-oil supply pressure at oil-fired appliances.

- B. Delegated Design: Design restraint and anchors for fuel-oil piping, ASTs, and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- C. Seismic Performance: Factory-installed support attachments for AST shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, and dimensions of individual components and profiles. Also include, where applicable, rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 1. Piping specialties.
 - 2. Valves: Include pressure rating, capacity, settings, and electrical connection data of selected models.
 - 3. Each type and size of fuel-oil storage tank. Indicate dimensions, weights, loads, components, and location and size of each field connection.
 - 4. Fuel-oil storage tank accessories.
 - 5. Fuel-oil storage tank piping specialties.
 - 6. Fuel-oil storage tank pumps.
 - 7. Fuel-oil transfer pumps.
 - 8. Fuel maintenance system.
 - 9. Liquid-level gage system.
 - 10. Leak-detection and monitoring system.
- B. Shop Drawings: For facility fuel-oil piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
 - 1. Shop Drawing Scale: 1/4 inch per foot.
 - 2. For fuel-oil storage tanks and pumps, include details of supports and anchors.
- C. Delegated-Design Submittal: For fuel-oil piping and equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Detail fabrication and assembly of anchors and seismic restraints.
 - 2. Design Calculations: Calculate requirements for selecting seismic restraints.
 - 3. Detail fabrication and assembly of pipe anchors, hangers, supports for multiple pipes, and attachments of the same to building structure.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and details, drawn to scale, on which fuel-oil piping is shown and coordinated with other installations, using input from installers of the items involved.

- B. Site Survey: Plans, drawn to scale, on which fuel-oil piping and tanks are shown and coordinated with other services and utilities.
- C. Qualification Data: For qualified professional engineer.
- D. Seismic Qualification Certificates: For ASTs, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. Brazing certificates.
- F. Welding certificates.
- G. Field quality-control reports.
- H. Warranty: Sample of special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuel-oil equipment and accessories to include in emergency, operation, and maintenance manuals.

1.8 MATERIALS MAINTENANCE SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Drive Belt: One for each belt-driven pump.

1.9 QUALITY ASSURANCE

- A. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
- B. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code Steel."
- C. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Comply with ASME B31.9, "Building Services Piping," for fuel-oil piping materials, installation, testing, and inspecting.
- F. Comply with requirements of the EPA and of state and local authorities having jurisdiction. Include recording of fuel-oil storage tanks and monitoring of tanks and piping.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Lift and support fuel-oil storage tanks only at designated lifting or supporting points, as shown on Shop Drawings. Do not move or lift tanks unless empty.
- B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- C. Store pipes and tubes with protective PE coating to avoid damaging the coating and to protect from direct sunlight.
- D. Store PE pipes and valves protected from direct sunlight.

1.11 PROJECT CONDITIONS

- A. Interruption of Existing Fuel-Oil Service: Do not interrupt fuel-oil service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary fuel-oil supply according to requirements indicated:
 - 1. Notify Construction Manager no fewer than two days in advance of proposed interruption of fuel-oil service.
 - 2. Do not proceed with interruption of fuel-oil service without Construction Manager's written permission.

1.12 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.13 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-oil storage tanks and flexible, double-containment piping and related equipment that fail in materials or workmanship within specified warranty period.
 - 1. Storage Tanks:
 - a. Failures include, but are not limited to, the following when used for storage of fuel oil at temperatures not exceeding 150 deg F:
 - 1) Structural failures including cracking, breakup, and collapse.
 - 2) Corrosion failure including external and internal corrosion of steel tanks.
 - b. Warranty Period: 30 years from date of Substantial Completion.
 - 2. Flexible, Double-Containment Piping and Related Equipment:
 - a. Failures due to defective materials or workmanship for materials installed together, including piping, dispenser sumps, entry boots, and sump mounting adapters.

b. Warranty Period: 30 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

- A. See Part 3 piping schedule articles for where pipes, tubes, fittings, and joining materials are applied in various services.
- B. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
 - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
 - 2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M, for butt and socket welding.
 - 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
 - 4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - a. Material Group: 1.1.
 - b. End Connections: Threaded or butt welding to match pipe.
 - c. Lapped Face: Not permitted underground.
 - d. Gasket Materials: Asbestos free, ASME B16.20 metallic, or ASME B16.21 nonmetallic, gaskets compatible with fuel oil.
 - e. Bolts and Nuts: ASME B18.2.1, cadmium-plated steel.
 - 5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
 - a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.
- C. Drawn-Temper Copper Tube: Comply with ASTM B 88, Type K.
 - 1. Copper Fittings: ASME B16.22, wrought copper, streamlined pattern.
 - 2. Bronze Flanges and Flanged Fittings: ASME B16.24, Class 150.
 - a. Gasket Material: Asbestos free, ASME B16.20, metallic, or ASME B16.21 nonmetallic, gaskets compatible with fuel oil.
 - b. Bolts and Nuts: ASME B18.2.1, cadmium-plated steel.
- D. Annealed-Temper Copper Tube: Comply with ASTM B 88, Type K.
 - 1. Copper Fittings: ASME B16.22, wrought copper, streamlined pattern.
 - 2. Flare Fittings: Comply with ASME B16.26 and SAE J513.
 - a. Copper fittings with long nuts.
 - b. Metal-to-metal compression seal without gasket.

c. Dryseal threads complying with ASME B1.20.3.

2.2 DOUBLE-CONTAINMENT PIPE AND FITTINGS

- A. Flexible, Double-Containment Piping: Comply with UL 971.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Environ Products, Inc.
 - b. OPW.
 - 2. Pipe Materials: PVDF complying with ASTM D 3222 for carrier pipe with mechanical couplings to seal carrier, and PE pipe complying with ASTM D 4976 for containment piping.
 - 3. Fiberglass sumps.
 - 4. Watertight sump entry boots, pipe adapters with test ports and tubes, coaxial fittings, and couplings.
 - 5. Minimum Operating Pressure Rating: 10 psig.
 - 6. Plastic to Steel Pipe Transition Fittings: Factory-fabricated fittings with plastic end matching or compatible with carrier piping, and steel pipe end complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
 - 7. Include design and fabrication of double-containment pipe and fitting assemblies with provision for field installation of cable leak-detection system in annular space between carrier and containment piping.
- B. Rigid, Double-Containment Piping: Comply with UL 971.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Ameron International; Fiberglass Pipe Group.
 - b. Conley Corporation.
 - c. Perma-Pipe, Inc.
 - d. Smith Fibercast.
 - 2. RTRP: ASTM D 2996 or ASTM D 2997 carrier and containment piping and mechanical couplings to seal carrier and containment piping or individually bonded joints.
 - a. Minimum Operating-Pressure Rating for RTRP NPS 2 and NPS 3: 150 psig.
 - b. Minimum Operating-Pressure Rating for RTRP NPS 4 and NPS 6: 125 psig. Compliance with UL 971 is not required for NPS 6 and larger piping.
 - c. Fittings: RTRF complying with ASTM D 2996 or ASTM D 2997, and made by RTRP manufacturer; watertight sump entry boots, termination, or other end fittings.

3. Include design and fabrication of double-containment pipe and fitting assemblies with provision for field installation of cable leak-detection system in annular space between carrier and containment piping.

2.3 PIPING SPECIALTIES

- A. Flexible Connectors: Comply with UL 567.
 - 1. Metallic Connectors:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) American Flexible Hose Co., Inc.
 - 2) Flexicraft Industries.
 - 3) FLEX-ING, Inc.
 - 4) Hose Master, Inc.
 - 5) Metraflex Company (The).
 - 6) Proco Products, Inc.
 - 7) Tru-Flex Metal Hose Corp.
 - 8) Unaflex.
 - b. Listed and labeled for aboveground and underground applications by an NRTL acceptable to authorities having jurisdiction.
 - c. Stainless-steel bellows with woven, flexible, bronze or stainless-steel, wirereinforcing protective jacket.
 - d. Minimum Operating Pressure: 150 psig.
 - e. End Connections: Socket, flanged, or threaded end to match connected piping.
 - f. Maximum Length: 30 inches.
 - g. Swivel end, 50-psig maximum operating pressure.
 - h. Factory-furnished anode.
 - 2. Nonmetallic Connectors:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) American Flexible Hose Co., Inc.
 - 2) Flexicraft Industries.
 - 3) FLEX-ING, Inc.
 - 4) Hose Master, Inc.
 - 5) Metraflex Company (The).
 - 6) Tru-Flex Metal Hose Corp.
 - b. Listed and labeled for underground applications by an NRTL acceptable to authorities having jurisdiction.
 - c. PFTE bellows with woven, flexible, bronze or stainless-steel, wire-reinforcing protective jacket.
 - d. Minimum Operating Pressure: 150 psig.
 - e. End Connections: Socket, flanged, or threaded end to match connected piping.
 - f. Maximum Length: 30 inches.
 - g. Swivel end, 50-psig maximum operating pressure.

- h. Factory-furnished anode.
- B. Y-Pattern Strainers:
 - 1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
 - 2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
 - 3. Strainer Screen: 80 mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
 - 4. CWP Rating: 125 psig.
- C. Basket Strainers:
 - 1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
 - 2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
 - 3. Strainer Screen: 80 mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
 - 4. CWP Rating: 125 psig.
- D. T-Pattern Strainers:
 - 1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
 - 2. End Connections: Grooved ends.
 - 3. Strainer Screen: 80 mesh startup strainer, and perforated stainless-steel basket with 57 percent free area.
 - 4. CWP Rating: 750 psig.
- E. Manual Air Vents:
 - 1. Body: Bronze.
 - 2. Internal Parts: Nonferrous.
 - 3. Operator: Screwdriver or thumbscrew.
 - 4. Inlet Connection: NPS 1/2.
 - 5. Discharge Connection: NPS 1/8.
 - 6. CWP Rating: 150 psig.
 - 7. Maximum Operating Temperature: 225 deg F.

2.4 JOINING MATERIALS

- A. Joint Compound and Tape: Suitable for fuel oil.
- B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.
- D. Bonding Adhesive for Fiberglass Piping: As recommended by fiberglass piping manufacturer.

2.5 MANUAL FUEL-OIL SHUTOFF VALVES

- A. See valve schedule in Part 3 for where each valve type is applied in various services.
- B. General Requirements for Metallic Valves, NPS 2 and Smaller for Liquid Service: Comply with UL 842.
 - 1. CWP Rating: 125 psig.
 - 2. Threaded Ends: Comply with ASME B1.20.1.
 - 3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
 - 4. Tamperproof Feature: Locking feature for valves indicated in the valve schedule.
 - 5. Service Mark: Initials "WOG" shall be permanently marked on valve body.
- C. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with UL 842.
 - 1. CWP Rating: 125 psig.
 - 2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
 - 3. Tamperproof Feature: Locking feature for valves indicated in the valve schedule.
 - 4. Service Mark: Initials "WOG" shall be permanently marked on valve body.
- D. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. BrassCraft Manufacturing Company; a Masco company.
 - b. Conbraco Industries, Inc.; Apollo Div.
 - c. Lyall, R. W. & Company, Inc.
 - d. McDonald, A. Y. Mfg. Co.
 - e. Perfection Corporation; A Subsidiary of American Meter Company.
 - 2. Body: Bronze, complying with ASTM B 584.
 - 3. Ball: Chrome-plated brass.
 - 4. Stem: Bronze; blowout proof.
 - 5. Seats: Reinforced TFE; blowout proof.
 - 6. Packing: Separate packnut with adjustable-stem packing threaded ends.
 - 7. Ends: Threaded, flared, or socket as indicated in the valve schedule.
 - 8. CWP Rating: 600 psig.
 - 9. Service Mark: Initials "WOG" shall be permanently marked on valve body.
- E. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. BrassCraft Manufacturing Company; a Masco company.
 - b. Conbraco Industries, Inc.; Apollo Div.
 - c. Lyall, R. W. & Company, Inc.
 - d. McDonald, A. Y. Mfg. Co.
 - e. Perfection Corporation; A Subsidiary of American Meter Company.
 - 2. Body: Bronze, complying with ASTM B 584.

- 3. Ball: Chrome-plated bronze.
- 4. Stem: Bronze; blowout proof.
- 5. Seats: Reinforced TFE; blowout proof.
- 6. Packing: Threaded-body packnut design with adjustable-stem packing.
- 7. Ends: Threaded, flared, or socket as indicated in the valve schedule.
- 8. CWP Rating: 600 psig.
- 9. Service Mark: Initials "WOG" shall be permanently marked on valve body.
- F. Two-Piece, Regular-Port Bronze Ball Valves with Bronze Trim: MSS SP-110.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. BrassCraft Manufacturing Company; a Masco company.
 - b. Conbraco Industries, Inc.; Apollo Div.
 - c. Lyall, R. W. & Company, Inc.
 - d. McDonald, A. Y. Mfg. Co.
 - e. Perfection Corporation; A Subsidiary of American Meter Company.
 - 2. Body: Bronze, complying with ASTM B 584.
 - 3. Ball: Chrome-plated bronze.
 - 4. Stem: Bronze; blowout proof.
 - 5. Seats: Reinforced TFE.
 - 6. Packing: Threaded-body packnut design with adjustable-stem packing.
 - 7. Ends: Threaded, flared, or socket as indicated in the valve schedule.
 - 8. CWP Rating: 600 psig.
 - 9. Service Mark: Initials "WOG" shall be permanently marked on valve body.

2.6 SPECIALTY VALVES

- A. Pressure Relief Valves: Comply with UL 842.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Anderson Greenwood; Division of Tyco Flow Control.
 - b. Fulflo Specialties, Inc.
 - c. Webster Fuel Pumps & Valves; a division of Capital City Tool, Inc.
 - 2. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.
 - 3. Body: Brass, bronze, or cast steel.
 - 4. Springs: Stainless steel, interchangeable.
 - 5. Seat and Seal: Nitrile rubber.
 - 6. Orifice: Stainless steel, interchangeable.
 - 7. Factory-Applied Finish: Baked enamel.
 - 8. Maximum Inlet Pressure: 150 psig.
 - 9. Relief Pressure Setting: 60 psig.
- B. Oil Safety Valves: Comply with UL 842.

TLC Engineering Solutions

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Anderson Greenwood; Division of Tyco Flow Control.
 - b. Suntec Industries Incorporated.
 - c. Webster Fuel Pumps & Valves; a division of Capital City Tool, Inc.
- 2. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.
- 3. Body: Brass, bronze, or cast steel.
- 4. Springs: Stainless steel.
- 5. Seat and Diaphragm: Nitrile rubber.
- 6. Orifice: Stainless steel, interchangeable.
- 7. Factory-Applied Finish: Baked enamel.
- 8. Manual override port.
- 9. Maximum Inlet Pressure: 60 psig.
- 10. Maximum Outlet Pressure: 3 psig.
- C. Emergency Shutoff Valves: Comply with UL 842.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Ameron International; Fiberglass Pipe Group.
 - b. Conley Corporation.
 - c. EMCO Wheaton; a Gardner Denver Company.
 - d. Environ Products, Inc.
 - e. OPW.
 - 2. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.
 - 3. Double poppet valve.
 - 4. Body: ASTM A 126, cast iron.
 - 5. Disk: FPM.
 - 6. Poppet Spring: Stainless steel.
 - 7. Stem: Plated brass.
 - 8. O-Ring: FPM.
 - 9. Packing Nut: PTFE-coated brass.
 - 10. Fusible link to close valve at 165 deg F.
 - 11. Thermal relief to vent line pressure buildup due to fire.
 - 12. Air test port.
 - 13. Maximum Operating Pressure: 0.5 psig.
- D. Mechanical Leak Detector: Comply with UL 842.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. FE Petro, Inc.
 - b. Red Jacket Pumps; a division of Veeder-Root.

- 2. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.
- 3. Body: ASTM A 126, cast iron.
- 4. O-Rings: Elastomeric compatible with fuel oil.
- 5. Piston and Stem Seals: PTFE.
- 6. Stem and Spring: Stainless steel.
- 7. Piston Cylinder: Burnished brass.
- 8. Indicated Leak Rate: Maximum 3 gph at 10 psig.
- 9. Leak Indication: Reduced flow.

2.7 FRP FUEL-OIL UST

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Containment Solutions, Inc.
 - 2. Xerxes Corporation.
- B. Description: Horizontal, FRP UST; UL 1316, double wall, with interstitial space and integral, hydrostatic, leak-detection and monitoring system.
- C. Construction: Fabricated with fiberglass-reinforced polyester resins; suitable for operation at atmospheric pressure; fabricated for the following loads:
 - 1. Depth of Bury: 3 feet from top of tank to finished surface.
 - 2. External Hydrostatic Pressure: To withstand general buckling with safety factor of 2:1 if hole is fully flooded.
 - 3. Surface Loads: AASHTO's "Specifications for Highway Bridges," H-20 axle loads of 32,000 lb.
- D. Capacities and Characteristics:
 - 1. Capacity: 5000 gallons.
 - 2. Diameter: 8 feet diameter.
 - 3. Length: 18 foot length.
 - 4. Connection Sizes:
 - a. Fill Line: 4 inch.
 - b. Vent Line: 3 inch.
 - c. Outlet: 2 inch.
 - d. Return: 2 inch.
 - e. Gage: 2 inch.
 - 5. Manholes:
 - a. Number Required: #2
 - b. Diameter: 24 inches.
 - 6. Fuel-Oil Grade Number: Number 2.

2.8 FUEL OIL UST ACCESSORIES

- A. Tank Manholes: 22-inch- minimum diameter; bolted, flanged, and gasketed, with extension collar; for access to inside of tank.
- B. Threaded pipe connection fittings on top of tank for fill, supply, return, vent, sounding, and gaging, in locations and of sizes indicated. Include cast-iron plugs for shipping.
- C. Striker Plates: Inside tank, on bottom below fill, vent, sounding, gage, and other tube openings.
- D. Lifting Lugs: For handling and installation.
- E. Supply Tube: Extension of supply piping fitting into tank, terminating 6 inches above tank bottom and cut at a 45-degree angle.
- F. Sounding and Gage Tubes: Extension of fitting into tank, terminating 6 inches above tank bottom and cut at a 45-degree angle.
- G. Containment Sumps: Fiberglass with sump base, add-on extension pieces as required, sump top, lid, and gasket-seal joints. Include sump entry boots for pipe penetrations through sidewalls.
- H. Sump Entry Boots: Two-part pipe fitting for field assembly and of size required to fit over pipe. Include gaskets shaped to fit sump sidewall, sleeves, seals, and clamps as required for liquid-tight pipe penetrations.
- I. Anchor Straps: Storage tank manufacturer's standard anchoring system, with straps, strapinsulating material, cables and turnbuckles, of strength at least one and one-half times maximum uplift force of empty tank without backfill in place.
- J. Filter Mat: Geotextile woven or spun filter fabric, in 1 or more layers, for minimum total weight of 3 oz./sq. yd.
- K. Overfill Prevention Valves: Factory fabricated or shop or field assembled from manufacturer's standard components. Include drop tube, cap, fill nozzle adaptor, check valve mechanism or other devices, and vent if required to restrict flow at 95 percent of tank capacity and to provide complete shutoff of filling at **[98] [99]** percent of tank capacity.

2.9 FUEL OIL STORAGE TANK PIPING SPECIALTIES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. EBW, Inc.
 - 2. Environ Products, Inc.
 - 3. Morrison Bros. Co.
 - 4. OPW.
 - 5. Preferred Utilities Manufacturing Corporation.
 - 6. Universal Valve Company.
- B. Fitting Materials: Cast iron, malleable iron, brass, or corrosion-resistant metal; suitable for fueloil service.
 - 1. Surface, Flush-Mounted Fittings: Waterproof and suitable for truck traffic.
 - 2. Aboveground-Mounted Fittings: Weatherproof.

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

- C. Spill-Containment Fill Boxes: Flush mounting, with drainage feature to drain oil into tank, threaded fill-pipe connection, and wrench operation.
- D. Fill Boxes: Flush mounting, with threaded fill-pipe connection and wrench operation.
- E. Locking Fill Boxes: Flush mounting, with locking-type inner fill cap for standard padlock and threaded fill-pipe connection.
- F. Supply and Sounding Drop Tubes: Fuel-oil supply piping or fitting, inside tank, terminating 6 inches above bottom of tank, and with end cut at a 45-degree angle.
- G. Pipe Adapters and Extensions: Compatible with piping and fittings.
- H. Suction Strainers and Check Valves: Bronze or corrosion-resistant metal components.
- I. Foot Valves and Antisiphon Valves: Poppet-type, bronze or corrosion-resistant metal components.
- J. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.
- K. Metal Manholes: 22 inch minimum diameter frame and cover. Furnish manhole units of adequate size for access to fittings if size is not indicated.
- L. Monitoring Well Caps: Locking pipe plug and manhole.

2.10 DUPLEX FUEL OIL TRANSFER PUMP SETS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Alyan Pump Company.
 - 2. Hydronic Modules Corporation.
 - 3. Preferred Utilities Manufacturing Corporation.
 - 4. Smith-Koch, Inc.
 - 5. Webster Fuel Pumps & Valves; a division of Capital City Tool, Inc.
- B. Description: Comply with HI M109.
 - 1. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.
 - 2. Type: Positive-displacement, rotary type.
 - 3. Impeller: Steel gear with crescent.
 - 4. Housing: Cast-iron foot mounted.
 - 5. Bearings: Bronze, self-lubricating.
 - 6. Shaft: Polished steel.
 - 7. Seals: Mechanical.
 - 8. Base: Steel.
 - 9. Pressure Relief: Built in.
 - 10. Discharge Check Valve: Built in.

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

TLC Engineering Solutions

- C. Drive: Direct close coupled.
- D. Controls:
 - 1. Run pumps to maintain minimum manifold pressure with outdoor-air temperature less than 60 deg F.
 - 2. Run pumps on seven-day schedule.
 - 3. Stage pumps on pressure at a common supply manifold.
 - 4. Alternate pumps to equalize run time.
 - 5. Alarm motor failure.
 - 6. Manual reset dry-run protection. Stop pumps if fuel level falls below pump suction.
 - 7. Deenergize and alarm pump locked rotor condition.
 - 8. Alarm open circuit, high and low voltage.
 - 9. Indicating lights for power on, run, and off normal conditions.
 - 10. Interface with automatic control system is specified in Division 23 Section "Instrumentation and Control for HVAC" to control and indicate the following:
 - a. Start/stop pump set when required by schedule, fuel-fired appliance operation, day tank level control, or weather conditions.
 - b. Operating status.
 - c. Alarm off-normal status.
- E. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
- F. Piping Furnished with Pumps: Steel with ferrous fittings and threaded or welded joints.
- G. Strainers Furnished with Pumps: Duplex, basket type with corrosion-resistant-metal-screen baskets.
- H. Capacities and Characteristics:
 - 1. Number of Stages: 2 stages.
 - 2. Capacity (Each Pump): 5 gph.
 - 3. Inlet Vacuum: 10 inches Hg.
 - 4. Discharge Pressure: 20 pis.
 - 5. Inlet and Outlet Size: 2 inches.
 - 6. Motor Speed: 1500 rpm.
 - 7. Motor Horsepower (Each Pump): 3/4 hp.
 - 8. Electrical Characteristics (Pump Set):
 - a. Volts: 120.
 - b. Phase: Single.

- c. Hertz: 60.
- d. Full Load Amperes: 30
- e. Minimum Circuit Ampacity: 30
- f. Maximum Overcurrent Protection: 40 amps

2.11 LIQUID-LEVEL GAGE SYSTEM

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Caldwell Systems Corporation.
 - 2. Clawson Tank Company.
 - 3. EBW, Inc.
 - 4. Highland Tank & Manufacturing Company, Inc.
 - 5. INCON, Inc.
 - 6. King Engineering Corp.
 - 7. Krueger Sentry Gauge.
 - 8. Pneumercator Inc.
 - 9. Preferred Utilities Manufacturing Corporation.
 - 10. Rochester Gauges, Inc.
 - 11. Tuthill Corporation; Tuthill Transfer Systems; Sotera Systems.
 - 12. Uehling Instrument Company.
 - 13. Venture Measurement Company, LLC.
- B. Description: Calibrated, liquid-level gage system complying with UL 180 with floats or other sensors and remote annunciator panel.
- C. Annunciator Panel: With visual and audible, high-tank-level and low-tank-level alarms, fuel indicator with registration in gallons, and overfill alarm. Include gage volume range that covers fuel-oil storage capacity.
- D. Controls: Electrical, operating on 120V ac.

2.12 LEAK-DETECTION AND MONITORING SYSTEM

- A. Cable and Sensor System: Comply with UL 1238.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Caldwell Systems Corporation.
 - b. Containment Solutions, Inc.
 - c. EBW, Inc.
 - d. Gems Sensors Inc.
 - e. Highland Tank & Manufacturing Company, Inc.
 - f. INCON, Inc.
 - g. In-Situ, Inc.
 - h. MSA; Instrument Div.
 - i. Perma-Pipe, Inc.
 - j. Pneumercator Inc.
 - k. Raychem Corp; Tyco Electronics Corporation.
 - I. Tuthill Corporation; Tuthill Transfer Systems; Sotera Systems.
 - m. Veeder-Root; a Danaher Corporation Company.

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

- 2. Calibrated, leak-detection and monitoring system with probes and other sensors and remote alarm panel for fuel-oil storage tanks and fuel-oil piping.
- 3. Include fittings and devices required for testing.
- 4. Controls: Electrical, operating on 120V ac.
- 5. Calibrated, liquid-level gage complying with UL 180 with floats or other sensors and remote annunciator panel.
- 6. Remote Annunciator Panel: With visual and audible, high-tank-level and low-tank-level alarms, fuel indicator with registration in gallons, and overfill alarm. Include gage volume range that covers fuel-oil storage capacity.
- 7. Controls: Electrical, operating on 120V ac.
- B. Hydrostatic System: Comply with UL 1238.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Caldwell Systems Corporation.
 - b. Containment Solutions, Inc.
 - c. EBW, Inc.
 - d. Gems Sensors Inc.
 - e. Highland Tank & Manufacturing Company, Inc.
 - f. INCON, Inc.
 - g. In-Situ, Inc.
 - h. MSA; Instrument Div.
 - i. Perma-Pipe, Inc.
 - j. Pneumercator Inc.
 - k. Raychem Corp; Tyco Electronics Corporation.
 - I. Tuthill Corporation; Tuthill Transfer Systems; Sotera Systems.
 - m. Veeder-Root; a Danaher Corporation Company.
 - 2. Calibrated, leak-detection and monitoring system with brine antifreeze solution, reservoir sensor, and electronic control panel to monitor leaks in inner and outer tank walls.
 - 3. Include fittings and devices required for testing.
 - 4. Controls: Electrical, operating on 120V ac.
 - 5. Calibrated, liquid-level gage complying with UL 180 with floats or other sensors and remote annunciator panel.
 - 6. Remote Annunciator Panel: With visual and audible, high-tank-level and low-tank-level alarms, fuel indicator with registration in gallons, and overfill alarm. Include gage volume range that covers fuel-oil storage capacity.
 - 7. Controls: Electrical, operating on 120V ac.

2.13 FUEL OIL

- A. Fuel Oil: ASTM D 396, Grade No. 2.
- B. Diesel Fuel Oil: ASTM D 975, Grade No. 2-D, general-purpose, high volatility.

2.14 LABELING AND IDENTIFYING

A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective

jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

2.15 CONCRETE MANHOLES

- A. Precast Concrete Manhole Sections: ASTM C 478, base and concentric-cone sections with integral ladder or steps.
- B. Cast-Iron Frame and Cover: Heavy-duty, water-resistant, cast-iron manhole frame, gasket, and bolted cover; 24 inch diameter, inside opening dimension; 8 inch frame riser height.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for fuel-oil piping system to verify actual locations of piping connections before equipment installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EARTHWORK

A. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.3 PREPARATION

- A. Close equipment shutoff valves before turning off fuel oil to premises or piping section.
- B. Comply with NFPA 30 and NFPA 31 requirements for prevention of accidental ignition.

3.4 OUTDOOR PIPING INSTALLATION

- A. Install underground fuel-oil piping buried at least 18 inches below finished grade. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.
 - 1. If fuel-oil piping is installed with less than 12 inches of cover to finished grade, install in containment piping.
- B. Steel Piping with Protective Coating:
 - 1. Apply joint cover kits to pipe after joining, to cover, seal, and protect joints.
 - 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer. Review protective coating damage with Architect prior to repair.
 - 3. Replace pipe having damaged PE coating with new pipe.
- C. Install double-containment, fuel-oil pipe at a minimum slope of 1 percent downward toward fueloil storage tank sump.
- D. Install vent pipe at a minimum slope of 2 percent downward toward fuel-oil storage tank sump.
- E. Assemble and install entry boots for pipe penetrations through sump sidewalls for liquid-tight joints.

- F. Install metal pipes and tubes, fittings, valves, and flexible connectors at piping connections to AST and UST.
- G. Install fittings for changes in direction in rigid pipe.
- H. Install system components with pressure rating equal to or greater than system operating pressure.
- I. Install pressure gage on suction and discharge from each pump. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."

3.5 INDOOR PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping free of sags and bends.
- G. Install fittings for changes in direction and branch connections.
- H. Verify final equipment locations for roughing-in.
- I. Comply with requirements for equipment specifications in Division 22 and Division 23 Sections for roughing-in requirements.
- J. Conceal pipe installations in walls, pipe spaces, or utility spaces; above ceilings; below grade or floors; and in floor channels unless indicated to be exposed to view.
- K. Prohibited Locations:
 - 1. Do not install fuel-oil piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
 - 2. Do not install fuel-oil piping in solid walls or partitions.
- L. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- M. Connect branch piping from top or side of horizontal piping.

- N. Install unions in pipes NPS 2 and smaller at final connection to each piece of equipment and elsewhere as indicated. Unions are not required on flanged devices.
- O. Do not use fuel-oil piping as grounding electrode.
- P. Install Y-pattern strainer on inlet side of fuel-oil pump.
- Q. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."
- R. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."
- S. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23 Section "Escutcheons for HVAC Piping."

3.6 VALVE INSTALLATION

- A. Install manual fuel-oil shutoff valves on branch connections to fuel-oil appliance.
- B. Install valves in accessible locations.
- C. Protect valves from physical damage.
- D. Install metal tag attached with metal chain indicating fuel-oil piping systems.
- E. Identify valves as specified in Division 23 Section "Identification for HVAC Piping and Equipment."
- F. Install oil safety valves at inlet of each oil-fired appliance.
- G. Install pressure relief valves in distribution piping between the supply and return lines.
- H. Install one-piece, bronze ball valve with hose end connection at low points in fuel-oil piping.
- I. Install manual air vents at high points in fuel-oil piping.
- J. Install emergency shutoff valves at dispensers.

3.7 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

- 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to "Quality Assurance" Article.
 - 1. Bevel plain ends of steel pipe.
 - 2. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.
- F. Flanged Joints: Install gasket material, size, type, and thickness for service application. Install gasket concentrically positioned.
- G. Flared Joints: Comply with SAE J513. Tighten finger tight, then use wrench according to fitting manufacturer's written recommendations. Do not overtighten.
- H. Fiberglass-Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.8 FUEL OIL UST INSTALLATION

- A. Excavate to sufficient depth for a minimum of 3 feet of earth cover from top of tank to finished grade. Allow for cast-in-place, concrete-ballast base plus 6 inches of sand or pea gravel between ballast base and tank. Extend excavation at least 12 inches around perimeter of tank.
- B. Set tie-down eyelets for hold-down straps in concrete-ballast base and tie to reinforcing steel.
- C. Place 6 inches of clean sand or pea gravel on top of concrete-ballast base.
- D. Set tank on fill materials and install hold-down straps.
- E. Connect piping.
- F. Install tank leak-detection and monitoring devices.
- G. Install containment sumps.
- H. Backfill excavation with clean sand or pea gravel in 12-inch lifts and tamp backfill lift to consolidate.
- I. Install filter mat between top of backfill material and earth fill.
- J. Install steel USTs with the STI-P3 corrosion-protection system according to STI R821 and STI R891. Protect anodes during tank placement and backfilling operations.
- K. Install composite, steel USTs according to STI R913 and STI R891.
- L. Install jacketed, steel USTs according to STI R923 and STI R891.

- M. Install FRP USTs with FRP hold-down straps, manhole extensions, and manhole risers.
- N. Fill storage tanks with fuel oil.

3.9 HANGER AND SUPPORT INSTALLATION

- A. Pipe hanger and support and equipment support materials and installation requirements are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 1-1/4 and Smaller: Maximum span, 84 inches; minimum rod size, 3/8 inch.
 - 2. NPS 1-1/2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 - 3. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
 - 4. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 1/2 inch.
 - 5. NPS 3: Maximum span, 12 feet; minimum rod size, 1/2 inch.
 - 6. NPS 4: Maximum span, 13 feet; minimum rod size, 5/8 inch.
- C. Support vertical steel pipe at each floor and at spacing not greater than 15 feet.
- D. Install hangers for horizontal, drawn-temper copper tubing with the following maximum spacing and minimum rod sizes:
 - 1. NPS 3/4 and Smaller: Maximum span, 60 inches; minimum rod size, 3/8 inch.
 - 2. NPS 1: Maximum span, 72 inches; minimum rod size, 3/8 inch.
 - 3. NPS 1-1/4: Maximum span, 84 inches; minimum rod size, 3/8 inch.
 - 4. NPS 1-1/2 and NPS 2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 - 5. NPS 2-1/2: Maximum span, 108 inches; minimum rod size, 1/2 inch.
 - 6. NPS 3: Maximum span, 10 feet; minimum rod size, 1/2 inch.
 - 7. NPS 4: Maximum span, 11 feet; minimum rod size, 5/8 inch.
- E. Support vertical copper tube at each floor and at spacing not greater than 10 feet.

3.10 FUEL-OIL PUMP INSTALLATION

- A. Transfer Pumps:
 - 1. Install pumps with access space for periodic maintenance including removal of motors, impellers, and accessories.
 - 2. Set pumps on and anchor to concrete base.
- B. Install two-piece, full-port ball valves at suction and discharge of pumps.
- C. Install mechanical leak-detector valves at pump discharge.
- D. Install Y-pattern strainer on inlet side of simplex fuel-oil pumps.
- E. Install check valve on discharge of simplex fuel-oil pumps.
- F. Install suction piping with minimum fittings and change of direction.

G. Install vacuum and pressure gage, upstream and downstream respectively, at each pump to measure the differential pressure across the pump. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."

3.11 LIQUID-LEVEL GAGE SYSTEM INSTALLATION

A. Install liquid-level gage system. Locate panel inside building where indicated.

3.12 LEAK-DETECTION AND MONITORING SYSTEM INSTALLATION

- A. Install leak-detection and monitoring system. Install alarm panel inside building where indicated.
 - 1. Double-Wall, Fuel-Oil Storage Tanks: Install probes.
 - 2. Single-Wall, Fuel-Oil Storage Tanks: Install probes as indicated.
 - 3. Double-Containment, Fuel-Oil Piping: Install leak-detection sensor probes in fuel-oil storage tank containment sumps and at low points in piping.
 - 4. Install liquid-level gage.

3.13 CONNECTIONS

- A. Install piping adjacent to equipment to allow service and maintenance.
- B. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment having threaded pipe connection.
- C. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.
- D. Connect piping to equipment with ball valve and union. Install union between valve and equipment.
- E. Install flexible piping connectors at final connection to burners or oil-fired appliances that must be moved for maintenance access.

3.14 LABELING AND IDENTIFYING

- A. Nameplates, pipe identification, and signs are specified in Division 23 Section "Identification for HVAC Piping and Equipment."
- B. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplates and signs on or near each service regulator, service meter, and earthquake valve.
 - 1. Text: In addition to identifying unit, distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
- C. Install detectable warning tape directly above fuel-oil piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs. Terminate tracer wire in an accessible area, and identify as "tracer wire" for future use with plastic-laminate sign.
 - 1. Piping: Over underground fuel-oil distribution piping.
 - 2. Fuel-Oil Storage Tanks: Over edges of each UST.

3.15 FIELD PAINTING OF ABOVEGROUND PIPING

- A. Comply with requirements in Division 09 painting Sections for painting interior and exterior fueloil piping.
- B. Paint exposed, exterior metal piping, valves, and piping specialties, except components with factory-applied paint or protective coating.
 - 1. Alkyd System: MPI EXT 5.1D.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
 - c. Topcoat: Exterior alkyd enamel semigloss.
 - d. Color: Gray.
- C. Paint exposed, interior metal piping, valves, and piping specialties, except components with factory-applied paint or protective coating.
 - 1. Latex Over Alkyd Primer System: MPI INT 5.1Q.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Interior latex matching topcoat.
 - c. Topcoat: Interior latex flat.
 - d. Color: Gray.
 - 2. Alkyd System: MPI INT 5.1E.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Interior alkyd matching topcoat.
 - c. Topcoat: Interior alkyd flat.
 - d. Color: Gray.
- D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.16 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
 - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 6. Use 3000-psig, 28-day, compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

3.17 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. Tanks: Minimum hydrostatic or compressed-air test pressures for fuel-oil storage tanks that have not been factory tested and do not bear the ASME code stamp or a listing mark acceptable to authorities having jurisdiction:
 - a. Single-Wall Tanks: Minimum 3 psig and maximum 5 psig.
 - b. Double-Wall Tanks:
 - 1) Inner Tanks: Minimum 3 psig and maximum 5 psig.
 - 2) Interstitial Space: Minimum 3 psig and maximum 5 psig, or 5.3-in. Hg vacuum.
 - c. Where vertical height of fill and vent pipes is such that the static head imposed on the bottom of the tank is greater than 10 psig, hydrostatically test the tank and fill and vent pipes to a pressure equal to the static head thus imposed.
 - d. Maintain the test pressure for one hour.
 - 2. Piping: Minimum hydrostatic or pneumatic test-pressures measured at highest point in system:
 - a. Fuel-Oil Distribution Piping: Minimum 5 psig for minimum 30 minutes.
 - b. Fuel-Oil, Double-Containment Piping:
 - 1) Carrier Pipe: Minimum 5 psig for minimum 30 minutes.
 - 2) Containment Conduit: Minimum 5 psig for minimum 60 minutes.
 - c. Suction Piping: Minimum 20-in. Hg for minimum 30 minutes.
 - d. Isolate storage tanks if test pressure in piping will cause pressure in storage tanks to exceed 10 psig.
 - 3. Inspect and test fuel-oil piping according to NFPA 31, "Tests of Piping" Paragraph; and according to requirements of authorities having jurisdiction.
 - 4. Test liquid-level gage for accuracy by manually measuring fuel-oil levels at not less than three different depths while filling tank and checking against gage indication.
 - 5. Test leak-detection and monitoring system for accuracy by manually operating sensors and checking against alarm panel indication.
 - 6. Start fuel-oil transfer pumps to verify for proper operation of pump and check for leaks.
 - 7. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 8. Bleed air from fuel-oil piping using manual air vents.

- D. Fuel-oil piping and equipment will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.18 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain leak-detection and monitoring systems.

3.19 OUTDOOR PIPING SCHEDULE

- A. Underground fuel-oil piping shall be one of the following. Size indicated is carrier-pipe size.
 - 1. Flexible, double-containment piping.
 - 2. Rigid, double-containment piping.
- B. Underground fuel-oil-tank fill and vent piping shall be one of the following:
 - 1. NPS 2 and Smaller: Steel pipe, steel or malleable-iron threaded fittings, and threaded joints. Coat pipe and fittings with protective coating for steel piping.
 - 2. NPS 2-1/2 and Larger: Steel pipe, steel welding fittings, and welded joints. Coat pipe and fittings with protective coating for steel piping.
- C. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
- D. Aboveground fuel-oil piping shall be one of the following:
 - 1. NPS 2 and Smaller: Steel pipe, steel or malleable-iron threaded fittings, and threaded joints.
 - 2. NPS 2-1/2 and Larger: Steel pipe, steel welding fittings, and welded joints.
 - 3. Drawn temper copper tube with wrought-copper fittings and brazed joints.

3.20 INDOOR PIPING SCHEDULE

- A. Aboveground fuel-oil piping shall be one of the following:
 - 1. NPS 1/2 and Smaller: Steel pipe, steel or malleable-iron threaded fittings, and threaded joints.
 - 2. NPS 5/8 to NPS 2: Steel pipe, steel or malleable-iron threaded fittings, and threaded joints.
 - 3. NPS 2-1/2 and Larger: Steel pipe, steel fittings, and welded or flanged joints.
 - 4. Steel pipe with malleable-iron fittings and threaded joints.
 - 5. Steel pipe with wrought-steel fittings and welded joints.
 - 6. Annealed-temper copper tube, brass fittings, and flared joints.
 - 7. Drawn-temper copper tubing, copper fittings, and brazed joints.

3.21 ABOVEGROUND MANUAL FUEL-OIL SHUTOFF VALVE SCHEDULE

- A. Distribution piping valves for pipe NPS 2 and smaller shall be one of the following:
 - 1. One-piece, bronze ball valve with bronze trim.
 - 2. Two-piece, full port, bronze ball valves with bronze trim.
- B. Distribution piping valves for pipe NPS 2-1/2 and larger shall be one of the following:
 - 1. Two-piece, full port, bronze ball valves with bronze trim.
 - 2. Bronze, lubricated plug valve.
- C. Valves in branch piping for single appliance shall be[one of] the following:
 - 1. One-piece, bronze ball valve with bronze trim.
 - 2. Two-piece, full port, bronze ball valves with bronze trim.

END OF SECTION 22 1113

SECTION 22 1114 LIQUEFIED PETROLEOUM GAS- LPG SYSTEM

1.1 GENERAL

Delegated design and construction for the installation of three underground 30,000 gallons LPG storage tanks, including the installation of new product LPG aboveground and underground piping, primary valves with related accessories, unloading/transfer station, pipe supports, new spread foundations and related accessories for a complete and code compliance system..

1.2 SUBMITTALS

- A. Product Data: For each type of product or equipment.
- B. Field quality-control test reports.
- C. Operation and Maintenance Data.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. PERFORM WORK IN ACCORDANCE WITH ALL APPLICABLE CODES AND REGULATORY REQUIREMENTS.
- C. PRIOR TO START WORK, EXAMINE AND VERIFY ALL CONDITIONS AND DIMENSIONS IN THE FIELD, AND NOTIFY THE ENGINEER INMEDIATELY OF ANY DISCREPANCY.
- D. COORDINATE THE WORK WITH ALL TRADES TO PROVIDE FOR THE PROPER EXECUTION OF THE CONTRACT
- E. KEEP THE PREMISES NEAT AND CLEAN AT ALL TIMES.
- F. PROTECT ALL AREAS OUTSIDE THE CONTRACT LIMIT SPECIALLY THOSE THROUGH WHICH MATERIALS MUST PASS TO PREVENT DAMAGE RESULTING FROM CONSTRUCTION OR MATERIALS HANDLING. RESTORE TO EXISTING CONSTRUCTION ORIGINAL CONDITION IF/WHEN DISTURBED
- G. FOLLOW THE MANUFACTURERS'STRICTEST WRITTEN RECOMMENDATIONS FOR HANDLING, INSTALLATION AND/OR APPLICATION OF ALL MATERIALS AND/OR PRODUCTS CONSISTENT WITH THE SKILL AND CARE NECESSARY FOR THE ORDERLY PROGRESS OF WORK.
- H. ALL SHOP DRAWINGS, INCLUDING EQUIPMENT AND MATERIALS SHALL BE REVIEWED AND APPROVED BY THE ENGINEER PRIOR TO ORDERING OR FABRICATION
- I. PERFORM ALL WORK IN A WORKMANLIKE MANNER.

- J. THE CONTRACTOR SHALL MAINTAIN AT THE SITE FOR THE OWNER AND ENGINEER A RECORD COPY OF THE DRAWINGS, MODIFICATIONS, CHANGE ORDERS, APPROVED SHOP DRAWINGS, SAMPLES AND REVISIONS, IN GOOD ORDER AND MARKED CURRENTLY TO RECORD FIELD CHANGES AND SELECTIONS MADE DURING CONSTRUCTION
- K. WHEN THE CONTRACTOR HAS ANY DOUBT REGARDING INFORMATION IN THE CONTRACT DOCUMENTS, HE SHALL SUBMIT IN WRITING A REQUEST FOR INFORMATION (RFI) TO THE ENGINEER. THE ENGINEER WILL ANSWER ALL RFI WITHIN A REASONABLE TIME. THE CONTRACTOR SHOULD CONTINUE WORK IN OTHER AREAS OF THE PROJECT AND IS NOT ENTITLED TO ADDITIONAL COMPENSATION OR TIME UNLESS A CHANGE ORDER IS ISSUED.
- L. UNLESS OTHERWISE NOTED ALL EQUIPMENT AND MATERIALS USED IN THIS PROJECT WILL BE NEW AND MANUFACTURED IN THE UNITED STATES.

1.4 DESIGN CRITERIA

System shall be designed and installed to supply the following loads:

- A. Laundry Area: 703,130 BTUH
- B. Kitchen Equipment:1,731,400 BTUH
- C. Domestic Water Heaters:6,000,000 BTUH
- D. Condensing Boilers: 12,000,000
- E. Three Underground 30,000 gallons each
- F. Recirculation's per day: Three (3) times
- G. Number supply days: 10

1.5 SCOPE OF WORK

1. INSTALLATION OF THREE NEW UNDERGROUND 30,000 GALLONS (WATER CAPACITY) PRESSURE VESSELS, ASME STAMPED, RATED AT 250 PSIG AT 125 °F, TO BE USE FOR THE STORAGE OF LIQUEFIED PETROLEUM GAS (PROPANE). SYSTEM WILL SERVE BOILERS, KITCHEN EQUIPMENT AND DOMESTIC WATER HEATERS.

2. CONSTRUCTION OF PRESSURE VESSELS CONCRETE PAD FOUNDATION.

3. INSTALLATION OF NEW ELECTRICAL GROUNDING SYSTEM, WHEN REQUIRED BY CODE,

- TO PROTECT THE PRESSURE VESSELS AND EQUIPMENT.
 - 4. INSTALLATION OF REMOTE EMERGENCY SHUTOFF VALVES.
 - 5. ALL PROVISIONS ON SECTIONS 6.30 OF NFPA 58 SHALL BE MET.

6. NO PART OF ANY UNDERGROUND TANK SHALL BE LOCATED LESS THAN 10 FT FROM ANY BUILDING AND PROPERTY LINE.

7. A FIRE SAFETY ANALYSIS SHALL BE PERFORMED BY THE CONTRACTOR AS RECOMMENDED BY NFPA 58.

8. CORROSION PROTECTION SHALL BE PROVIDED PER NFPA 58.

9. CONSTRUCTION DRAWINGS OF THE DIFFERENT TRADES SHOWING AND RELATED TO THE LPG SYSTEM SHALL BE PREPARED AND SUBMITTED TO THE ARCHITECT/ENGINEER FOR REVIEW AND APPROVAL INCLUDING ENGINEERING CALCULATIONS FOR THE SYSTEM DESIGN PRIOR TO ANY SYSTEM CONSTRUCTION. SYSTEM DESIGN SHALL BE PERFORMED BY A PROFESSIONAL ENGINEER REGISTERED IN THE US VIRGIN ISLANDS. 10. FIRST AND SECOND STAGE PRESSURE REDUCING STATIONS COMPLETE WITH: PRESSURE TRANSMITTER PER STAGE (SIGNAL TO BAS), ISOLATION VALVES, PRESSURE GAUGES, WORKING/MONITOR PRV VALVE, BY-PASS WITH MANUAL AND AUTOMATIC VALVE. AUTOMATIC VALVE ON BY-PASS ONLY ON FIRST STAGE AND TO OPEN WHEN VAPOR PRESSURE DROPS BELOW 60 PSIG (ADJUSTABLE).

1.6 DESIGN AND CONSTRUCTION CODES, STANDARDS AND REFERENCES

- 1. ST. CROIX BUILDING CODE,
- 2. INTERNATIONAL MECHANICAL CODE,
- 3. INTERNATIONAL FIRE CODE,
- 4. NFPA 58, LIQUEFIED PETROLEUM GAS CODE,
- 5. NFPA 54, NATIONAL FUEL GAS CODE,
- 6 ASME B31.3, PROCESS PIPING.

1.7 SAFETY & ENVIRONMENT:

1. ALL CONSTRUCTION OCCURING WITHIN 50 FT. OF LP GAS INSTALLATIONS WILL BE CONSIDERED HOT WORK AND WILL REQUIRE PERMIT AND ATMOSPHERE MONITORING. PERMITS AND MONITORING WILL BE PERFORMED BY THE CONTRACTOR FOLLOWING INSTRUCTIONS FROM THE OWNER.

2. A FIRE EXTINGUISHER SHALL BE PRESENT AT ALL TIMES WITHIN 25 FT. FROM CONSTRUCTION AND FIRE WATCH WILL BE REQUIRED DURING CONSTRUCTION.

3. THE CONTRACTOR SHALL COMPLY WITH ALL LOCAL AND FEDERAL REGULATIONS RELATED TO LABOR, SAFETY AND ENVIRONMENTAL PROTECTION. ALL REQUIRED EQUIPMENT INSPECTIONS, EMPLOYEE TRAINING, RECORDS AND REPORTS SHALL BE CURRENT AND AVAILABLE FOR OWNER REVIEW.

4. ALL PERSONNEL INVOLVED IN CONSTRUCTION ACTIVITIES SHALL BE PROPERLY TRAINED AND / OR QUALIFIED (IE. LP - GAS SERVICE, ELECTRICIANS, PLUMBERS, ETC.)

5. AN EROSION CONTROL PLAN (CES PLAN) SHALL BE PREPARED AND ESTABLISHED TO PREVENT CONTAMINATION OF WATER BODIES. IF REQUIRED, IT SHALL BE SUBMITTED FOR APPROVAL TO THE LOCAL PERMIT AUTHORITY OR THE ENVIRONMENTAL QUALITY AGENCY.

1.8 EXCAVATIONS:

1. CONTRACTOR SHALL SUBMIT AN EXCAVATION PLAN, TO THE OWNER OR HIS REPRESENTATIVE, PRIOR TO STARTING THE JOB.

2. BEFORE EXCAVATIONS CONSULT WITH THE OWNER TO DETERMINE LOCATION OF ANY BURIED UTILITY & SERVICE LINES OR PIPELINES.

3. EXERCISE CAUTION DURING EXCAVATIONS PAYING ATTENTION TO ANY SIGNS OF EXISTING UNDERGROUND INSTALLATIONS.

4. THE CONTRACTOR MUST TAKE ALL NECESSARY PRECAUTIONS TO PROTECT EMPLOYEES WORKING IN OR NEAR THE EXCAVATIONS. COMPLY WITH OSHA EXCAVATIONS, TRENCHING AND SHORING SAFETY REQUIREMENTS (29 CFR 1926, SUBPART P.)

5. EXCAVATIONS SHALL BE COVERED WITH STEEL PLATES OF ADEQUATE BEARING CAPACITY AFTER EACH WORK SHIFT OR THE AREA SHALL BE PROTECTED TO RESTRAINT ACCESS TO THE PUBLIC.

6. SAFE TRAFFIC AND PEDESTRIAN ACCESS SHALL BE MAINTAINED DURING CONSTRUCTION ACTIVITIES.

7. ASPHALT, CONCRETE OR PLANTING AFFECTED DURING CONSTRUCTION SHALL BE REPAIRED TO ITS ORIGINAL CONDITION.

1.9 PRESSURE VESSELS:

1. PRESSURE VESSELS USED IN THIS PROJECT SHALL BE NEW AND SHALL COMPLY WITH THE FOLLOWING SPECIFICATIONS:

A. DESIGNED, MANUFACTURED AND STAMPED ACCORDING TO ASME SECTION VIII PRESSURE VESSELS STANDARD,

B. DESIGN PRESSURE OF 250 PSIG AT DESIGN TEMPERATURE 125 ° F, MINIMUM

C. DESIGN CAPACITY OF 30,000 W.G. FOR UNDERGROUND SERVICE.

D. PAINT/CORROSION PROTECTION: THE VESSEL SHALL BE PAINTED WITH A CORROSION PROTECTION COATING ADEQUATE FOR UNDERGROUND USE, APPLY ADDITIONAL COATINGS AS MAY BE NECESARRY FOR EXTRA PROTECTION DUE TO SOIL CONDITIONS. PROVIDE ADDITIONAL CATHODIC CORROSION PROTECTION SYSTEM PER NFPA 58.

E. SIGN SHALL BE PROVIDED AS REQUIRED BY THE LOCAL AGENCY, INCLUDING THE FOLLOWING INFORMATION: FLAMMABLE GAS, SUPPLIER'S NAME AND 24 HRS. EMERGENCY CONTACT TELEPHONE NUMBER.

F. 20 POUNDS ABC FIRE EXTINGUISHERS SHALL BE INSTALLED INSIDE LP- GAS VESSEL AREA NEAR THE ACCESS GATE, SHALL BE ATTACHED TO THE WALL AND PROTECTED WITH RED PLASTIC COVERED, LABELED " FIRE EXTINGUISHER".

G. THE PRESSURE RELIEF DEVICES SHALL BE PROVIDED WITH RAIN CAPS.

2.0 PAINT AND LABELING:

1. PIPE, FITTINGS, PARTS, STRUCTURES AND EQUIPMENT SHALL BE PRIMED AND PAINTED WITH A CORROSION INHIBITING COATING SYSTEM.

2. PIPING SHALL BE PAINTED USING THE SPECIFIED TRADE COLOR CODE OR THE OWNER SPECIFIED COLORS.

3. NAMEPLATES, SAFETY RELIEF VALVES OR ANY OTHER SAFETY DEVICES MUST NOT BE PAINTED.

4. AREAS AFFECTED OR DISTURBED DURING CONSTRUCTION ACTIVITIES SHALL BE PAINTED USING PAINT AND COLOR EQUIVALENT TO EXISTING.

5. PAINT APPLICATION AND FINISH SHALL BE IN ACCORDANCE WITH MANUFACTURER RECOMMENDATIONS.

6. FLOW DIRECTION AND PIPE CONTENT SHALL BE LABELED ON THE INLET AND OUTLET OF EQUIPMENT, AT CHANGE OF DIRECTION, AT INTERVALS NOT EXCEEDING 20 FEET INSIDE BUILDINGS AND AT 50 FEET INTERVALS ON OTHER PIPING SECTIONS. USE SET MARK SNAP-AROUND PIPE MARKERS BY SETON, OR SIMILAR.

7. ALL EQUIPMENT, FILTERS, VALVES, INSTRUMENTATION AND ELECTRICAL DEVICES SHALL BE LABELED USING A PERMANENT, AFFIXED ENGRAVED PLASTIC TAGS USING THE STANDARD EQUIPMENT NUMBERING SYSTEM ESTABLISHED BY THE OWNER. TAGS MUST FOLLOW EXISTING DIMENSIONS AND COLOR PRACTICES.

2.1 PIPING, FITTING AND VALVES RATINGS & SPECIFICATIONS:

- 1. PIPING SYSTEMS AND COMPONENTS SHALL BE INSTALLED BY QUALIFIED PERSONNEL.
- 2. ABOVE GROUND PIPING SHALL BE PROTECTED AGAINST PHYSICAL DAMAGE.
- 3. LP GAS AT PRESSURES EXCEEDING 20 PSI SHALL NOT BE PIPED INTO ANY BUILDING.
- 4. LP GAS PIPING SHALL BE SEAMLESS AND COMPLY WITH THE FOLLOWING:

A. STEEL PIPE - ASTM A53/A53M, STANDARD SPECIFICATION FOR PIPE, STEEL, BLACK AND HOT-DIPPED, ZINC-COATED, WELDED AND SEAMLESS.

B. STEEL PIPE - ASTM A106, STANDARD SPECIFICATION FOR SEAMLESS CARBON STEEL PIPE FOR HIGH-TEMPERATURE SERVICE.

- 5. FITTINGS SHALL BE FORGED CARBON STEEL.
- 6. CAST-IRON PIPE FITTINGS SHALL NOT TO BE USED.

7. VALVES OTHER THAN CONTAINER VALVES - PRESSURE CONTAINING METAL PARTS OF VALVES, USED IN PIPING SYSTEM SHALL BE STEEL, DUCTILE (NODULAR) IRON, MALLEABLE IRON OR BRASS. DUCTILE IRON SHALL MEET THE REQUIREMENTS OF ASTM A53, STANDARD SPECIFICATION FOR FERRITIC DUCTILE IRON PRESSURE-RETAINING CASTINGS FOR USE AT ELEVATED TEMPERATURES, OR EQUIVALENT. MALLEABLE IRON SHALL MEET THE REQUIREMENTS OF ASTM A47, STANDARD SPECIFICATION FOR FERRITIC MALLEABLE IRON CASTINGS, OR EQUIVALENT. ALL MATERIALS USED, INCLUDING VALVE SEAT DISC, PACKING, SEALS, AND DIAPHRAGMS, SHALL BE RESISTANT TO ACTION OF LP-GAS UNDER SERVICE CONDITIONS.

8. PIPE, FITTINGS AND VALVES USED AT PRESSURES HIGHER THAN CONTAINER PRESSURE, SUCH AS ON DISCHARGE OF LIQUID TRANSFER PUMPS, SHALL BE SUITABLE FOR A MINIMUM WORKING PRESSURE OF 350 PSI, OR 400 PSI WATER, OIL, AND GAS (WOG) RATING.

9. PIPE, FITTINGS AND VALVES USED WITH LP-GAS LIQUID OR VAPOR AT OPERATING PRESSURE OVER 125 PSI, AND AT OR BELOW CONTAINER PRESSURE (250 PSI), SHALL BE SUITABLE FOR A MINIMUM WORKING PRESSURE OF 250 PSI.

10. PIPE, FITTINGS AND VALVES USED WITH LP-GAS VAPOR AT OPERATING PRESSURE OF 125 PSI OR LESS SHALL BE SUITABLE FOR A MINIMUM WORKING PRESSURE OF 125 PSI.

11. HOSE, QUICK CONNECTORS, HOSE CONNECTIONS, AND FLEXIBLE CONNECTORS SHALL BE FABRICATED OF MATERIALS THAT ARE RESISTANT TO THE ACTION OF LP-GAS BOTH AS LIQUID AND VAPOR. WHEN WIRE BRAID IS USED FOR REINFORCEMENT, IT SHALL BE OF CORROSION RESISTANT MATERIAL SUCH AS STAINLESS STEEL. HOSE SHALL BE DESIGNED FOR A WORKING PRESSURE OF AT LEAST 350 PSIG, WITH A SAFETY FACTOR OF 5 TO 1 AND COMPLY WITH ANSI/UL 569, STANDARD FOR PIGTAILS AND FLEXIBLE HOSE CONNECTORS FOR LP-GAS, OR ANSI/UL, STANDARD FOR LP-GAS HOSE.

12. HOSE SHALL BE CONTINUOUSLY MARKED TO PROVIDE AT LEAST THE FOLLOWING INFORMATION: LP-GAS HOSE OR LPG HOSE, MAXIMUM WORKING PRESSURE, MANUFACTURER'S NAME OR CODED DESIGNATION, MONTH OR QUARTER AND YEAR OF MANUFACTURE AND PRODUCT IDENTIFICATION.

13. HOSE ASSEMBLIES, AFTER THE APPLICATION OF COUPLINGS, SHALL HAVE A DESIGN CAPABILITY OF NOT LESS THAN 700 PSIG. IF A PRESSURE TEST IS PERFORMED, SUCH ASSEMBLIES SHALL BE PRESSURE TESTED AT 120 PERCENT OF THE MAXIMUM WORKING PRESSURE (350 PSIG MINIMUM) OF THE HOSE. HOSE ASSEMBLIES SHALL BE LEAK TESTED AT THE TIME OF INSTALLATION AT NOT LESS THAN THE OPERATING PRESSURE OF THE SYSTEM IN WHICH THEY ARE INSTALLED.

14. EMERGENCY SHUT-OFF VALVES SHALL BE PROVIDED AND SHALL INCORPORATE ALL OF THE FOLLOWING MEANS OF CLOSING:

A. AUTOMATIC SHUT-OFF THERMAL (FIRE) ACTUATION. WHERE FUSIBLE ELEMENTS ARE USED, THEY SHALL HAVE A MELTING POINT NOT EXCEEDING 250°F.

B. MANUAL SHUT-OFF FROM A REMOTE LOCATION.

C. MANUAL SHUT-OFF AT THE INSTALLED LOCATION.

15. WELD ALL VAPOR PIPING. WELD ALL LIQUID PIPING.

16. WELDED PIPE ABOVE 2 INCHES NPS TO BE MADE USING FULL PENETRATION WELDS ONLY.

17. ABOVEGROUND PIPING USED FOR VAPOR SERVICE SHALL BE SCHEDULE 80.

18. ABOVEGROUND PIPING AND FITTINGS USED FOR LIQUID AND VAPOR SERVICE SHALL BE SCHEDULE 80.

19. THREADED CONNECTIONS, WHEN REQUIRED, SHALL BE SEALED WITH A PIPE JOINT COMPOUND SUITABLE FOR LP GAS SERVICE.

20. PIPING THAT CONTAIN LIQUID LP-GAS AND THAT CAN BE ISOLATED BY VALVING AND THAT REQUIRES HYDROSTATIC RELIEF VALVES SHALL HAVE AN OPERATING PRESSURE OF 350 PSIG OR A PRESSURE THAT IS EQUIVALENT TO THE MAXIMUM DISCHARGE PRESSURE OF ANY PUMP OR OTHER SOURCE FEEDING THE FIXED PIPING SYSTEM IF IT IS GREATER THAN 350 PSIG.

21. A HYDROSTATIC RELIEF VALVE SHALL BE INSTALLED AT EACH SECTION OF PIPING, INCLUDING HOSE, IN WHICH LPG LIQUID CAN BE ISOLATED BETWEEN SHUT OFF VALVES. 22. FLOW METERS, WHEN REQUIRED, SHALL BE INSTALLED IN ACCORDANCE WITH THE MANUFACTURERS' INSTALLATION INSTRUCTIONS.

23. FLOW METERS, WHEN REQUIRED, SHALL BE INSTALLED SO THAT THE METER HOUSING IS NOT SUBJECT TO EXCESSIVE STRAINS FROM THE CONNECTING PIPING. IF NOT PROVIDED IN THE PIPING DESIGN, THE USE OF FLEXIBLE CONNECTORS SHALL BE PERMITTED. FLEXIBLE CONNECTORS SHALL NOT EXCEED 36 IN. (1 M) IN TOTAL LENGTH.

24. HYDROSTATIC RELIEF VALVES DESIGNED TO RELIEVE THE HYDROSTATIC PRESSURE THAT CAN DEVELOP IN SECTIONS OF LIQUID PIPING BETWEEN CLOSED SHUTOFF VALVES SHALL HAVE PRESSURE SETTINGS NOT LESS THAN 400 PSIG (2.8 MPAG) OR MORE THAN 500 PSIG (3.5 MPAG).

25. ANY OF THE VALVES THAT ARE NOT CONNECTED FOR SERVICE SHALL BE PLUGGED CAPPED.

2.2 VENTING AND PURGING OF LP GAS:

1. THE POINT OF DISCHARGE FROM THE REQUIRED PRESSURE RELIEF DEVICE SHALL BE LOCATED NOT LESS THAN 3 FT. HORIZONTALLY AWAY FROM ANY BUILDING OPENING, BELOW THE LEVEL OF SUCH DISCHARGE AND NOT BENEATH ANY BUILDING UNLESS THIS SPACE IS WELL VENTILATED TO THE OUTSIDE AND LOCATED NOT LESS THAN 5 FEET IN ANY DIRECTION AWAY FROM ANY SOURCE OF IGNITION, OPENING INTO DIRECT - VENT APPLIANCES, OR MECHANICAL VENTILATION INTAKES.

2.3 TESTING:

1. AFTER ASSEMBLY, THE PIPING SYSTEM, INCLUDING HOSES, SHALL BE TESTED AND PROVEN FREE OF LEAKS, AT NO LESS THAN THE NORMAL OPERATING PRESSURE. A SOAP OR LEAK TESTING SOLUTION SHALL BE USED TO CHECK ALL CONNECTIONS. TEST SHALL BE WITNESS AND CERTIFIED BY A PROFESSIONAL ENGINEER.

2.4 WELDING

1. WHEN JOINTS IN CARBON STEEL ARE WELDED, WELDING PROCEDURE SPECIFICATION MUST BE SUBMITTED FOR APPROVAL AND QUALIFIED WELDERS MUST BE USED AS PER ASME SECTION IX "WELDING AND BRAZING QUALIFICATIONS".

2. WELDED JOINTS ON PIPING 2"NPS AND LARGER SHALL BE MADE USING BUTT JOINTS. PIPE JOINTS LESS THAN 2" NPS CAN BE MADE USING SOCKET WELD FITTINGS.

3. WELDING SHALL BE MADE USING A QUALIFIED WELDING PROCEDURE SPECIFICATIONS ADEQUATE FOR THE WELDS TO BE MADE AND ACCEPTED BY THE WELDING INSPECTOR.

4. CONTRACTOR SHALL HIRE THE SERVICE OF AN INDEPENDENT AWS CERTIFIED WELDING INSPECTOR WHO SHALL PERFORM PERIODIC IN PROCESS INSPECTIONS AND 100% VISUAL INSPECTIONS OF ALL WELDED JOINTS OF ALL FINISHED WELDS. VISITS AND RESULTS SHALL BE DOCUMENTED.

5. 5% OF PIPING BUTT WELDED JOINTS SHALL RECEIVE RADIOGRAPHIC EXAMINATION IN ACCORDANCE WITH SECTION V OF THE ASME CODE LATEST EDITION.

6. STRUCTURAL WELDS SHALL BE SUBJECTED TO LIQUID PENETRANT TESTING OF ALL JOINTS.

7. ALL DEFECTS EXCEEDING REJECTION CRITERIA SHALL BE PROMPTLY CORRECTED AND DOCUMENTED.

2.5 ADDITIONAL REQUIREMENTS TO BE CONSIDERED BY CONTRACTOR:

- 1. PROPER GROUNDING WHERE REQUIRED BY CODE
- 2. PROPER LIGHTING TO ILLUMINATE THE AREA
- 3. LIGHTNING PROTECTION, VERIFY CODE COMPLIANCE
- 4. PROPER CLASSIFIED ELECTRICAL SYSTEM
- 5. SEISMIC SHUT-OFF VALVE IN THE VAPOR SUPPLY PIPE TO HOSPITAL FACILITIES.
- 6. PROPER WINDSTORM RESISTANT DESIGN; 175 MPH WIND SPEED
- 7. CHAIN LINK FENCE AROUND LPG TANKS WITH TWO LOCKED GATES
- 8. PROPER HAZARD SIGNAGE SHOULD BE PROVIDED

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- 9. MANUAL ALARM STATIONS WITH AUDIO AND VISUAL NOTIFICATION DEVICES
- 10. CCTV VIEWS AT THE LPG TANK AREA
- 11. PREPARE A HAZARDOUS AREA CLASSIFICATION DRAWING
- 12. ALL ABOVEGROUND PIPING SHALL BE SUPPORTED AND PROTECTED AGAINST PHYSICAL DAMAGE.
- 13. UNLOADING STATION SHALL BE PROPERLY ANCHORED, WITH BREAKAWAY PROVISION TO RETAIN PIPING INTACT ON THE SYSTEM SIDE

END OF DOCUMENT 22 1120

SECTION 22 1116 DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
 - 2. Encasement for piping.
 - 3. Specialty valves.
 - 4. Flexible connectors.
 - 5. Escutcheons.
 - 6. Sleeves and sleeve seals.
 - 7. Wall penetration systems.

1.3 SUBMITTALS

- A. Product Data: For the following products:
 - 1. Specialty valves.
 - 2. Transition fittings.
 - 3. Dielectric fittings.
 - 4. Flexible connectors.
 - 5. Backflow preventers and vacuum breakers.
 - 6. Escutcheons.
 - 7. Sleeves and sleeve seals.
 - 8. Water penetration systems.
- B. Water Samples: Specified in "Cleaning" Article.
- C. Coordination Drawings: For piping in equipment rooms and other congested areas, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
 - 1. Fire-suppression-water piping.
 - 2. Domestic water piping.
 - 3. Compressed air piping.
 - 4. HVAC hydronic piping.
- D. Field quality-control reports.

1.4 QUALITY ASSURANCE
- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 61 for potable domestic water piping and components.

1.5 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 FACILITY WATER DISTRIBUTION PIPING

A. This Section specifies the water distribution piping system, including potable cold, hot and re-circulated hot water piping, and hydronics, including associated fittings, and specialties within the building.

2.3 RELATED SECTIONS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification sections apply to work of this section.

2.4 REFERENCE DOCUMENTS

- A. ASTM F 2389-06 Standard Specification for Pressure-rated Polypropylene (PP) Piping Systems
- B. CSA B137.11 Polypropylene (PP-R) Pipe and Fittings for Pressure Applications
- C. NSF/ANSI 14 Plastic Piping System Components and Related Materials
- D. NSF/ANSI 61 Drinking Water Systems Components Health Effects

2.5 DEFINITIONS

A. Definitions shall be in accordance with local plumbing codes and ASTM F 2389.

2.6 SUBMITTALS

A. Material list naming each product to be used identified by manufacturer and product number.

2.7 QUALITY ASSURANCE

- A. Material shall be certified by NSF International as complying with NSF 14, NSF 61, and ASTM F 2389 or CSA B137.11.
- B. Material shall comply with manufacturers specifications.

C. Special Engineered products shall be certified by NSF International as complying with NSF 14.

2.8 PIPE AND PIPING PRODUCTS

- A. Pipe shall be manufactured from a PP-R resin (Fusiolen) meeting the short-term properties and long-term strength requirements of ASTM F 2389. The pipe shall contain no rework or recycled materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. All pipe shall be made in an extrusion process. Domestic hot water and heating piping shall contain a fiber layer (faser) to restrict thermal expansion. All pipe shall comply with the rated pressure requirements of ASTM F 2389. All pipe shall be certified by NSF International as complying with NSF 14, NSF 61, and ASTM F 2389 or CSA B137.11.
- B. Pipe shall be aquatherm® Green Pipe®, MF (Faser®), or Blue Pipe® MF (Faser®) available from Aquatherm, NA. Piping specifications and ordering information are available at <u>www.aquatherm.com</u>.

2.9 FITTINGS

- A. Fittings shall be manufactured from a PP-R resin (Fusiolen) meeting the short-term properties and long-term strength requirements of ASTM F 2389. The fittings shall contain no rework or recycled materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. All fittings shall be certified by NSF International as complying with NSF 14, NSF 61, and ASTM F 2389 or CSA B137.11.
- B. Fittings shall be Aquatherm® Green Pipe® available from Aquatherm, NA. Fittings specifications and ordering information are available at <u>www.aquatherm.com</u>.

2.10 WARRANTY

- A. Manufacturer shall warrant pipe and fittings for 10 years to be free of defects in materials or manufacturing.
- B. Warranty shall cover labor and material costs of repairing and/or replacing defective materials and repairing any incidental damage caused by failure of the piping system due to defects in materials or manufacturing.
- C. Warranty shall be in effect only upon submission by the contractor to the manufacturer of a valid pressure/leak test documentation indicating that the system was tested and passed the manufacturer's proscribed pressure/leak test.

2.11 VALVES

- A. Valves with PP-R bodies shall be manufactured from a PP-R resin (Fusiolen) meeting the short-term properties and long-term strength requirements of ASTM F 2389. The valves shall contain no rework or recycled materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material.
- B. Valves with brass bodies shall be manufactured in accordance with the manufacturer's specifications and shall by certified by NSF International as complying with NSF 61.

C. Valves shall be aquatherm® Fusiotherm® available from Aquatherm, NA. Valve specifications and ordering information are available at <u>www.aquatherm.com</u>.

2.12 SMOKE AND FIRE RATINGS

A. Where indicated on the drawings that a Plenum-rated Piping System is needed, then the pipe shall be wrapped and/or insulated with standard pipe insulation, field installed. The pipe wrap or insulation shall meet the requirements of CAN/ULC-S102.2-03 or ASTM E84. The system shall have a Flame Spread Classification of less than 25 and Smoke Development rating of less than 50.

2.13 UV PROTECTION

A. Where indicated on the drawings that the pipe will be exposed to direct UV light for more than 30 days, it shall be provided with a Factory applied, UV-resistant coating or alternative UV protection.

2.14 THERMAL AND VAPOR

A. Where standard pipe insulation is indicated on the drawings or in these specifications, the contractor shall provide a thermal (radiant, conductive, and convective) and vapor barrier insulation. The insulation products shall be provided in ______ R-value and ______thickness or as indicated on the drawings or elsewhere in these specifications. The standard pipe insulation shall be UV resistant, CFC-free, non-porous, non-fibrous, and resist mold growth.

2.15 PIPING APPLICATIONS

- A. Install listed pipe materials and joining methods below in the following applications:
 - 1. Underground Piping: Polypropylene (PP-R) piping in SDR 7.4,11, or 17.6 per manufacturer's instructions and ASTM D2774.
 - 2. Aboveground: Polypropylene (PP-R) piping in SDR 7.4, 11 or 17.6 based on the required minimum pressure rating and use temperature.

2.16 FUSION WELDING OF JOINTS

- A. Install fittings and joints using socket-fusion, electofusion, or butt-fusion as applicable for the fitting type. All fusion-weld joints shall be made in accordance with the pipe and fitting manufacturer's specifications and product standards.
- B. Fusion-weld tooling, welding machines, and electrofusion devices shall be as specified by the pipe and fittings manufacturer.
- C. Prior to joining, the pipe and fittings shall be prepared in accordance with F 2389 and the manufacturer's specifications.
- D. Joint preparation, setting and alignment, fusion process, cooling times and working pressure shall be in accordance with the pipe and fitting manufacturer's specifications.

2.17 VALVE APPLICATIONS

A. Install gate valves close to the main on each branch and riser serving 2 or more equipment connections and where indicated.

- B. Install gate or ball valves on the inlet to each equipment item, on each supply to each plumbing fixture not having stops on supplies, and elsewhere as indicated.
- C. Install drain valve at the base of each riser, at low points of horizontal runs, and where required to drain water distribution piping system.
- D. Install swing check valve on the discharge side of each pump and elsewhere as indicated.
- E. Install ball valves in each hot-water circulating loop and the discharge side of each pump.

2.18 PIPING INSTALLATIONS

- A. Install hangers and supports at intervals specified in the applicable Mechanical Code and/or as recommended by pipe manufacturer.
- B. Support vertical piping at each floor and as specified in the applicable Mechanical Code. For piping 2" (63mm) and smaller mid-story guides shall be employed.
- C. Fire stopping shall be provided to both be compatible with the Aquatherm Piping and meet the requirements of ASTM E 814 or ULC S115, "Fire Tests of Through-Penetration Firestops". Pipe insulation shall be terminated 3 to 6 inches from where the pipe passes through a fire stop, as recommended by the fire stop manufacturer.

2.19 INSPECTING AND CLEANING

A. The pipes should be flushed with cold water after finishing the installation. Inspect and test piping systems following procedures of authorities having jurisdiction and as specified by the piping system manufacturer.

2.20 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
 - 1. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
 - 2. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
 - 3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
 - 4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with balland-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
 - 5. Copper Pressure-Seal-Joint Fittings:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Elkhart Products
 - 2) NIBCO INC.
 - 3) Viega; Plumbing and Heating Systems.
 - b. NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.

- c. NPS 2-1/2 to NPS 4: Cast-bronze or wrought-copper fitting with EPDMrubber O-ring seal in each end.
- B. Soft Copper Tube: ASTM B 88, Type K water tube, annealed temper.
 - 1. Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

2.21 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free, unless otherwise indicated; full-face or ring type unless otherwise indicated.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Solder Filler Materials: ASTM B 32, lead-free alloys. Include water flushable flux according to ASTM B 813.

2.22 ENCASEMENT FOR PIPING

- A. Standard: ASTM A 674 or AWWA C105.
- B. Form: Sheet.
- C. Material: LLDPE film of 0.008-inch minimum thickness or high-density, cross-laminated PE film of 0.004-inch minimum thickness.
- D. Color: Black.

2.23 SPECIALTY VALVES

- A. Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty metal valves.
- B. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves, drain valves, backflow preventers, and vacuum breakers.

2.24 TRANSITION FITTINGS

- A. General Requirements:
 - 1. Same size as pipes to be joined.
 - 2. Pressure rating at least equal to pipes to be joined.
 - 3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
- C. Sleeve-Type Transition Coupling: AWWA C219.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. Dresser, Inc.; Dresser Piping Specialties.
- b. JCM Industries.
- c. Viking Johnson; c/o Mueller Co.
- D. Plastic-to-Metal Transition Fittings:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Charlotte Pipe and Foundry Company.
 - b. Harvel Plastics, Inc.
 - c. Spears Manufacturing Company.
 - 2. Description: CPVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert and one solvent-cement-socket or threaded end.
- E. Plastic-to-Metal Transition Unions:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Colonial Engineering, Inc.
 - b. NIBCO INC.
 - c. Spears Manufacturing Company.
 - 2. Description: CPVC four-part union. Include brass or stainless-steel threaded end, solvent-cement-joint or threaded plastic end, rubber O-ring, and union nut.

2.25 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.
- B. Dielectric Unions:
 - 1. Description:
 - a. Pressure Rating: 150 psig at 180 deg F.
 - b. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
 - 1. Description:
 - a. Factory-fabricated, bolted, companion-flange assembly.
 - b. Pressure Rating: 150 psig.
 - c. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- D. Dielectric-Flange Kits:

- 1. Description:
 - a. Nonconducting materials for field assembly of companion flanges.
 - b. Pressure Rating: 150 psig.
 - c. Gasket: Neoprene or phenolic.
 - d. Bolt Sleeves: Phenolic or polyethylene.
 - e. Washers: Phenolic with steel backing washers.
- E. Dielectric Couplings:
 - 1. Description:
 - a. Galvanized-steel coupling.
 - b. Pressure Rating: 300 psig at 225 deg F.
 - c. End Connections: Female threaded.
 - d. Lining: Inert and noncorrosive, thermoplastic.
- F. Dielectric Nipples:
 - 1. Description:
 - a. Electroplated steel nipple complying with ASTM F 1545.
 - b. Pressure Rating: 300 psig at 225 deg F.
 - c. End Connections: Male threaded or grooved.
 - d. Lining: Inert and noncorrosive, propylene.

2.26 ESCUTCHEONS

- A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.
- B. One Piece, Cast Brass: Polished, chrome-plated finish with setscrews.
- C. One Piece, Deep Pattern: Deep-drawn, box-shaped brass with chrome-plated finish.

2.27 SLEEVES

- A. Cast-Iron Wall Pipes: Fabricated of cast iron, and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc-coated, with plain ends.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with setscrews.

2.28 SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, used to fill annular space between pipe and sleeve.

- 1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
- 2. Pressure Plates: Carbon steel.
- 3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.29 WALL PENETRATION SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following: SIGMA.
- B. Description: Wall-sleeve assembly, consisting of housing and gland, gaskets, and pipe sleeve.
 - 1. Carrier-Pipe Deflection: Up to 5 percent without leakage.
 - 2. Housing: Ductile-iron casting with hub, waterstop, anchor ring, and locking devices. Include gland, bolts, and nuts.
 - 3. Housing-to-Sleeve Gasket: EPDM rubber.
 - 4. Housing-to-Carrier-Pipe Gasket: AWWA C111, EPDM rubber.
 - 5. Pipe Sleeve: AWWA C151, ductile-iron pipe or ASTM A 53/A 53M, Schedule 40, zinc-coated steel pipe.

2.30 GROUT

- A. Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydrauliccement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install underground copper tube in PE encasement according to ASTM A 674 or AWWA C105.
- D. Install shutoff valve immediately upstream of each dielectric fitting.

- E. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for pressure-reducing valves.
- F. Install domestic water piping level without pitch and plumb.
- G. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- H. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- I. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- J. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- K. Install piping adjacent to equipment and specialties to allow service and maintenance.
- L. Install piping to permit valve servicing.
- M. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.
- N. Install piping free of sags and bends.
- O. Install fittings for changes in direction and branch connections.
- P. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- Q. Install pressure gages on suction and discharge piping from each plumbing pump and packaged booster pump. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages.
- R. Install thermostats in hot-water circulation piping. Comply with requirements in Division 22 Section "Domestic Water Pumps" for thermostats.
- S. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.
- T. Exposed piping in finished areas shall be chrome plated.

3.3 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Pressure-Sealed Joints: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.
- E. Copper-Tubing Grooved Joints: Roll groove end of tube. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for roll-grooved joints.
- F. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.4 VALVE INSTALLATION

- A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for valve installations.
- B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball or gate valves for piping NPS 2 and smaller. Use gate valves for piping NPS 2-1/2 and larger.
- C. Install calibrated balancing valves in each hot-water circulation return branch and discharge side of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flow. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for calibrated balancing valves.

3.5 TRANSITION FITTING INSTALLATION

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
 - 1. NPS 1-1/2 and Smaller: Fitting-type coupling.
 - 2. NPS 2 and Larger: Sleeve-type coupling.
- C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plasticto-metal transition fittings or unions.

3.6 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or nipples.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flange kits.
- D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.7 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.
 - 1. Vertical Piping: MSS Type 8 or 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet If Indicated: MSS Type 49, spring cushion rolls.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Support vertical piping and tubing at base and at each floor.
- C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.
- D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
 - 2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
 - 3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 - 4. NPS 2-1/2: 108 inches with 1/2-inch rod.
 - 5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
 - 6. NPS 6: 10 feet with 5/8-inch rod.
- E. Install supports for vertical copper tubing every 10 feet.
- F. Support piping and tubing not listed in this article according to Florida Plumbing Code, MSS SP-69 and manufacturer's written instructions.

3.8 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment and machines to allow service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

- 1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
- 2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
- 3. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 22 plumbing fixture Sections for connection sizes.
- 4. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.9 ESCUTCHEON INSTALLATION

- A. Install escutcheons for penetrations of walls, ceilings, and floors.
- B. Escutcheons for New Piping:
 - 1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
 - 2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
 - 3. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.

3.10 SLEEVE INSTALLATION

- A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.
- B. Sleeves are not required for core-drilled holes.
- C. Permanent sleeves are not required for holes formed by removable PE sleeves.
- D. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.
- E. Install sleeves in new partitions, slabs, and walls as they are built.
- F. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants" for joint sealants.
- G. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants" for joint sealants.
- H. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using wall penetration systems specified in this Section.
- I. Seal space outside of sleeves in concrete slabs and walls with grout.

- J. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation unless otherwise indicated.
- K. Install sleeve materials according to the following applications:
 - 1. Sleeves for Piping Passing through Concrete Floor Slabs: Molded PE.
 - 2. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Stack sleeve fittings.
 - a. Extend sleeves 2 inches above finished floor level.
 - b. For pipes penetrating floors with membrane waterproofing, extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified. Secure flashing between clamping flanges. Install section of castiron soil pipe to extend sleeve to 2 inches above finished floor level. Comply with requirements in Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
 - 3. Sleeves for Piping Passing through Gypsum-Board Partitions:
 - a. Steel pipe sleeves for pipes smaller than NPS 6.
 - b. Galvanized-steel sheet sleeves for pipes NPS 6 and larger.
 - c. Exception: Sleeves are not required for water supply tubes and waste pipes for individual plumbing fixtures if escutcheons will cover openings.
 - 4. Sleeves for Piping Passing through Concrete Roof Slabs: Molded PE.
 - 5. Sleeves for Piping Passing through Exterior Concrete Walls:
 - a. Steel pipe sleeves for pipes smaller than NPS 6.
 - b. Cast-iron wall pipe sleeves for pipes NPS 6 and larger.
 - c. Install sleeves that are large enough to provide 1-inch annular clear space between sleeve and pipe or pipe insulation when sleeve seals are used.
 - d. Do not use sleeves when wall penetration systems are used.
 - 6. Sleeves for Piping Passing through Interior Concrete Walls:
 - a. Steel pipe sleeves for pipes smaller than NPS 6.
 - b. Galvanized-steel sheet sleeves for pipes NPS 6 and larger.
- L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestop materials and installations.

3.11 SLEEVE SEAL INSTALLATION

A. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.

B. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.12 IDENTIFICATION

- A. Identify system components. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.
- B. Label pressure piping with system operating pressure.

3.13 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Piping Inspections:
 - 1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - 2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
 - 3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
 - 4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- C. Piping Tests:
 - 1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - 2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
 - 3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source

and allow standing for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

- 5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
- 6. Prepare reports for tests and for corrective action required.
- D. Domestic water piping will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.14 ADJUSTING

- A. Perform the following adjustments before operation:
 - 1. Close drain valves, hydrants, and hose bibbs.
 - 2. Open shutoff valves to fully open position.
 - 3. Open throttling valves to proper setting.
 - 4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
 - b. Adjust calibrated balancing valves to flows indicated.
 - 5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
 - 6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
 - 7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
 - 8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.15 CLEANING

- A. Clean and disinfect potable and non-potable domestic water piping as follows:
 - 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 - 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.

- c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
- d. Submit water samples in sterile bottles to the local health department or a bacteriological laboratory recognized and acceptable to the Architect. Repeat procedures if biological examination shows contamination.
- B. Clean non-potable domestic water piping as follows:
 - 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 - 2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- C. Prepare and submit a letter and laboratory reports of purging and disinfecting activities by the organization certifying successful completion of the sterilization. Submit all reports to the Architect.
- D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.16 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
- D. Under-building-slab, domestic water, building service piping, NPS 3 and smaller, shall be one of the following:
 - 1. Soft copper tube, ASTM B 88, Type K ; wrought-copper solder-joint fittings; and brazed joints.
- E. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 shall be one of the following:
 - 1. Soft copper tube, ASTM B 88, Type K ; wrought-copper solder-joint fittings; and brazed joints.
- F. Under-building-slab, domestic water piping, NPS 2 and smaller, shall be one of the following:

- 1. Soft copper tube, ASTM B 88, Type K; wrought-copper solder-joint fittings; and brazed joints.
- G. Aboveground domestic water piping, NPS 2 and smaller, shall be one of the following:
 - 1. Hard copper tube, ASTM B 88, Type L; wrought-copper solder-joint fittings and soldered joints.
 - 2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.
- H. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be one of the following:
 - 1. Hard copper tube, ASTM B 88, Type L; wrought-copper solder-joint fittings and soldered joints.
 - 2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.
- I. Aboveground domestic water piping, NPS 5 to NPS 8, shall be one of the following:
 - 1. Hard copper tube, ASTM B 88, Type L; wrought-copper solder-joint fittings and soldered joints.
 - 2. Hard copper tube, ASTM B 88, Type L; grooved-joint copper-tube appurtenances; and grooved joints.

3.17 VALVE SCHEDULE

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Shutoff Duty: Use ball or gate valves for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.
 - 2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.
 - 3. Hot-Water Circulation Piping, Balancing Duty: Calibrated balancing valves.
- B. Use check valves to maintain correct direction of domestic water flow to and from equipment.
- C. Iron grooved-end valves may be used with grooved-end piping.

END OF DOCUMENT 22 1116

SECTION 22 1119 DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following domestic water piping specialties:
 - 1. Vacuum breakers.
 - 2. Backflow preventers.
 - 3. Water pressure-reducing valves.
 - 4. Balancing valves.
 - 5. Temperature-actuated water mixing valves.
 - 6. Strainers.
 - 7. Outlet boxes.
 - 8. Hose bibbs.
 - 9. Wall hydrants.
 - 10. Water hammer arresters.
 - 11. Air vents.
 - 12. Trap-seal primer valves.
 - 13. Trap-seal primer systems.

1.3 **PERFORMANCE REQUIREMENTS**

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control test reports.
- C. Operation and Maintenance Data: For domestic water piping to include in emergency, Operation and Maintenance Manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. NSF Compliance:
 - 1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
 - Comply with NSF 61, "Drinking Water System Components Health Effects; Sections 1 through 9."

PART 2 - PRODUCTS

2.1 VACUUM BREAKERS

- A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Co.
 - b. FEBCO; SPX Valves & Controls.
 - c. Watts Industries, Inc.; Water Products Div.
 - d. Zurn Plumbing Products Group; Wilkins Div.
 - 2. Standard: ASSE 1001.
 - 3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
 - 4. Body: Bronze.
 - 5. Inlet and Outlet Connections: Threaded.
 - 6. Finish: Chrome plated.
- B. Hose-Connection Vacuum Breakers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Watts Industries, Inc.; Water Products Div.
 - b. Woodford Manufacturing Company.
 - c. Zurn Plumbing Products Group; Light Commercial Operation.
 - d. Zurn Plumbing Products Group; Wilkins Div.
 - 2. Standard: ASSE 1011.
 - 3. Body: Bronze, nonremovable, with manual drain.
 - 4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
 - 5. Finish: Chrome or nickel plated.

2.2 BACKFLOW PREVENTERS

- A. Reduced-Pressure-Principle Backflow Preventers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Co.
 - b. FEBCO; SPX Valves & Controls.
 - c. Watts Industries, Inc.; Water Products Div.
 - d. Zurn Plumbing Products Group; Wilkins Div.
 - 2. Standard: ASSE 1013.
 - 3. Operation: Continuous-pressure applications.
 - 4. Configuration: See Plumbing Drawings.
- B. Double-Check Backflow-Prevention Assemblies:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Apollo Co.
- b. FEBCO; SPX Valves & Controls.
- c. Watts Industries, Inc.; Water Products Div.
- d. Zurn Plumbing Products Group; Wilkins Div.
- 2. Standard: ASSE 1015.
- 3. Operation: Continuous-pressure applications.
- C. Backflow-Preventer Test Kits:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Co.
 - b. FEBCO; SPX Valves & Controls.
 - c. Watts Industries, Inc.; Water Products Div.
 - d. Zurn Plumbing Products Group; Wilkins Div.
 - 2. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

2.3 WATER PRESSURE-REDUCING VALVES

- A. Water Regulators:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Co.
 - b. Watts Industries, Inc.; Water Products Div.
 - c. Zurn Plumbing Products Group; Wilkins Div.
 - 2. Standard: ASSE 1003.
 - 3. Pressure Rating: Initial working pressure of 150 psig.
 - 4. Design Inlet Pressure: See Plumbing Drawings.
 - 5. Design Outlet Pressure Setting: See Plumbing Drawings.
 - 6. Body: Bronze with chrome-plated finish for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3.
 - 7. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.

2.4 BALANCING VALVES

- A. Copper-Alloy Calibrated Balancing Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Armstrong International, Inc.
- b. ITT Industries; Bell & Gossett Div.
- c. NIBCO INC.
- d. Taco, Inc.
- e. Watts Industries, Inc.; Water Products Div.
- 2. Type: Ball valve with two readout ports and memory setting indicator.
- 3. Body: Brass or bronze.
- 4. Size: Same as connected piping.
- 5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

2.5 TEMPERATURE-ACTUATED WATER MIXING VALVES

- A. Water-Temperature Limiting Devices:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Co.
 - b. Powers; a Watts Industries Co.
 - c. Symmons Industries, Inc.
 - d. Watts Industries, Inc.; Water Products Div.
 - e. Zurn Plumbing Products Group; Wilkins Div.
 - 2. Standard: ASSE 1017.
 - 3. Pressure Rating: 125 psig.
 - 4. Type: Thermostatically controlled water mixing valve.
 - 5. Material: Bronze body with corrosion-resistant interior components.
 - 6. Connections: Threaded inlets and outlet.
 - 7. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
 - 8. Tempered-Water Setting: See Plumbing Drawings.
 - 9. Tempered-Water Design Flow Rate: See Plumbing Drawings.
 - 10. Valve Finish: Chrome plated.
- B. Primary, Thermostatic, Water Mixing Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong International, Inc.
 - b. Leonard Valve Company.
 - c. Powers; a Watts Industries Co.
 - d. Symmons Industries, Inc.
 - 2. Standard: ASSE 1017.
 - 3. Pressure Rating: 125 psig.
 - 4. Type: Cabinet-type, thermostatically controlled water mixing valve.
 - 5. Material: Bronze body with corrosion-resistant interior components.
 - 6. Connections: Threaded inlets and outlet.
 - 7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
 - 8. Valve Pressure Rating: 125 psig minimum, unless otherwise indicated.
 - 9. Tempered-Water Setting: See Plumbing Drawings.

- 10. Tempered-Water Design Flow Rate: See Plumbing Drawings.
- 11. Pressure Drop at Design Flow Rate: See Plumbing Drawings.
- 12. Valve Finish: Rough bronze.
- 13. Piping Finish: Copper.
- 14. Cabinet: Factory-fabricated, stainless steel, for surface mounting and with hinged, stainless-steel door.
- C. Manifold, Thermostatic, Water-Mixing-Valve Assemblies:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Leonard Valve Company.
 - b. Powers; a Watts Industries Co.
 - c. Symmons Industries, Inc.
 - 2. Description: Factory-fabricated, cabinet-type, thermostatically controlled, watermixing-valve assembly in two-valve parallel arrangement.
 - 3. Large-Flow Parallel: Thermostatic water mixing valve and downstream pressure regulator with pressure gages on inlet and outlet.
 - 4. Intermediate-Flow Parallel: Thermostatic water mixing valve and downstream pressure regulator with pressure gages on inlet and outlet.
 - 5. Small-Flow Parallel: Thermostatic water mixing valve.
 - 6. Thermostatic Mixing Valves: Comply with ASSE 1017. Include check stops on hot- and cold-water inlets and shutoff valve on outlet.
 - 7. Water Regulator(s): Comply with ASSE 1003. Include pressure gage on inlet and outlet.
 - 8. Component Pressure Ratings: 125 psig minimum, unless otherwise indicated.
 - 9. Cabinet: Factory-fabricated, stainless steel, for surface mounting and with hinged, stainless-steel door.
 - 10. Selected Large Flow, Tempered Water Valve Size: See Plumbing Drawings.
 - 11. Tempered-Water Setting: See Plumbing Drawings.
 - 12. Unit Tempered-Water Design Flow Rate: See Plumbing Drawings.
 - 13. Unit Minimum Tempered-Water Design Flow Rate: See Plumbing Drawings.
 - 14. Unit Pressure Drop at Design Flow Rate: See Plumbing Drawings.
 - 15. Unit Tempered-Water Outlet Size: See Plumbing Drawings.
 - 16. Unit Hot- and Cold-Water Inlet Size: See Plumbing Drawings.
 - 17. Thermostatic Mixing Valve and Water Regulator Finish: Rough bronze.

- 18. Piping Finish: Copper.
- D. Individual-Fixture, Water Tempering Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Co.
 - b. Leonard Valve Company.
 - c. Powers; a Watts Industries Co.
 - d. Watts Industries, Inc.; Water Products Div.
 - e. Zurn Plumbing Products Group; Wilkins Div.
 - 2. Standard: ASSE 1016, thermostatically controlled water tempering valve.
 - 3. Pressure Rating: 125 psig minimum, unless otherwise indicated.
 - 4. Body: Bronze body with corrosion-resistant interior components.
 - 5. Temperature Control: Adjustable.
 - 6. Inlets and Outlet: Threaded.
 - 7. Finish: Rough or chrome-plated bronze.
 - 8. Tempered-Water Setting: See Plumbing Drawings.
 - 9. Tempered-Water Design Flow Rate: See Plumbing Drawings.

2.6 STRAINERS FOR DOMESTIC WATER PIPING

- A. Y-Pattern Strainers:
 - 1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
 - 2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 and larger.
 - 3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
 - 4. Screen: Stainless steel with round perforations, unless otherwise indicated.
 - 5. Drain: Factory-installed, hose-end drain valve.

2.7 OUTLET BOXES

- A. Clothes Washer Outlet Boxes:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Engineering Company.
 - b. Guy Gray Manufacturing Co., Inc.
 - c. Bradley, Inc.
 - d. Watts Industries, Inc.; Water Products Div.
 - 2. Mounting: Recessed.
 - 3. Material and Finish: Enameled-steel or epoxy-painted-steel box and faceplate.
 - 4. Faucet: Combination, valved fitting or separate hot- and cold-water, valved fittings complying with ASME A112.18.1. Include garden-hose thread complying with ASME B1.20.7 on outlets.
 - 5. Supply Shutoff Fittings: NPS 1/2 gate, globe, or ball valves and NPS 1/2 copper, water tubing.
 - 6. Drain: NPS 2 standpipe and P-trap for direct waste connection to drainage piping.

- 7. Inlet Hoses: Two 60-inch- long, rubber household clothes washer inlet hoses with female, garden-hose-thread couplings. Include rubber washers.
- 8. Drain Hose: One 48-inch- long, rubber household clothes washer drain hose with hooked end.
- B. Icemaker Outlet Boxes:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Engineering Company.
 - b. IPS Corporation.
 - c. Bradley, Inc.
 - 2. Mounting: Recessed.
 - 3. Material and Finish: Enameled-steel or epoxy-painted-steel box and faceplate.
 - 4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 or smaller copper tube outlet.
 - 5. Supply Shutoff Fitting: NPS 1/2 gate, globe, or ball valve and NPS 1/2 copper, water tubing.

2.8 HOSE BIBBS

- A. Hose Bibbs:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Čompany.
 - b. Prier Products, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Watts Drainage Products Inc.
 - e. Woodford Manufacturing Company.
 - f. Zurn Plumbing Products Group; Light Commercial Operation.
 - g. Zurn Plumbing Products Group; Specification Drainage Operation.
 - 2. Standard: ASME A112.18.1 for sediment faucets.
 - 3. Body Material: Bronze.
 - 4. Seat: Bronze, replaceable.
 - 5. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
 - 6. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
 - 7. Pressure Rating: 125 psig.
 - 8. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
 - 9. Finish for Equipment Rooms: Rough bronze, or chrome plated.
 - 10. Finish for Finished Rooms: Chrome plated.
 - 11. Operation for Equipment Rooms: Wheel handle.
 - 12. Operation for Finished Rooms: Operating key.
 - 13. Include operating key with each operating-key hose bibb.

2.9 WALL HYDRANTS

- A. Nonfreeze Wall Hydrants:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Josam Company.
- b. Prier Products, Inc.
- c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
- d. Watts Drainage Products Inc.
- e. Woodford Manufacturing Company.
- f. Zurn Plumbing Products Group; Light Commercial Operation.
- g. Zurn Plumbing Products Group; Specification Drainage Operation.
- 2. Standard: ASME A112.21.3M for concealed outlet, self-draining wall hydrants.
- 3. Pressure Rating: 125 psig.
- 4. Operation: Loose key.
- 5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
- 6. Inlet: NPS 3/4.
- 7. Description: See Plumbing Drawings.
- 8. Operating Keys(s): One with each wall hydrant.
- B. Nonfreeze, Hot- and Cold-Water Wall Hydrants:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company.
 - b. Prier Products, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Watts Drainage Products Inc.
 - e. Woodford Manufacturing Company.
 - f. Zurn Plumbing Products Group; Specification Drainage Operation.
 - 2. Standard: ASME A112.21.3M for exposed outlet, self-draining wall hydrants.
 - 3. Pressure Rating: 125 psig.
 - 4. Operation: Loose key.
 - 5. Casings and Operating Rods: Of length required to match wall thickness. Include wall clamps.
 - 6. Inlets: NPS 3/4 or NPS 1.
 - 7. See Plumbing Drawings.
 - 8. Operating Keys(s): One with each wall hydrant.
- C. Moderate-Climate Wall Hydrants:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company.
 - b. Prier Products, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Watts Drainage Products Inc.
 - e. Woodford Manufacturing Company.
 - f. Zurn Plumbing Products Group; Light Commercial Operation.
 - g. Zurn Plumbing Products Group; Specification Drainage Operation.
 - 2. Standard: ASME A112.21.3M for exposed outlet, self-draining wall hydrants.
 - 3. Pressure Rating: 125 psig.
 - 4. Operation: Loose key.
 - 5. Inlet: NPS 3/4.

- 6. Description: See Plumbing Drawings.
- 7. Operating Keys(s): One with each wall hydrant.

2.10 DRAIN VALVES

- A. Ball-Valve-Type, Hose-End Drain Valves:
 - 1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
 - 2. Pressure Rating: 125-psig minimum CWP.
 - 3. Size: NPS 3/4.
 - 4. Body: Copper alloy.
 - 5. Ball: Chrome-plated brass.
 - 6. Seats and Seals: Replaceable.
 - 7. Handle: Vinyl-covered steel.
 - 8. Inlet: Threaded or solder joint.
 - 9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.
- B. Stop-and-Waste Drain Valves:
 - 1. Standard: MSS SP-110 for ball valves or MSS SP-80 for gate valves.
 - 2. Pressure Rating: 200-psig minimum CWP or Class 125.
 - 3. Size: NPS 3/4.
 - 4. Body: Copper alloy or ASTM B 62 bronze.
 - 5. Drain: NPS 1/8 side outlet with cap.

2.11 WATER HAMMER ARRESTERS

- A. Water Hammer Arresters:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company.
 - b. Sioux Chief Manufacturing Company
 - c. Precision Plumbing Products
 - 2. Standard: ASSE 1010 or PDI-WH 201.
 - 3. Type: Copper tube with piston with threaded end connection.
 - 4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.12 AIR VENTS

- A. Bolted-Construction Automatic Air Vents:
 - 1. Body: Bronze.
 - 2. Pressure Rating: 125-psig minimum pressure rating at 140 deg F.
 - 3. Float: Replaceable, corrosion-resistant metal.

- 4. Mechanism and Seat: Stainless steel.
- 5. Size: NPS 1/2 minimum inlet.
- 6. Inlet and Vent Outlet End Connections: Threaded.

2.13 TRAP-SEAL PRIMER VALVES

- A. Supply-Type, Trap-Seal Primer Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. PPP Inc.
 - b. Sioux Chief Manufacturing Company, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Watts Industries, Inc.; Water Products Div.
 - 2. Standard: ASSE 1018.
 - 3. Pressure Rating: 125 psig minimum.
 - 4. Body: Bronze.
 - 5. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
 - 6. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
 - 7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

2.14 TRAP-SEAL PRIMER SYSTEMS

- A. Trap-Seal Primer Systems:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following: PPP Inc.
 - 2. Standard: ASSE 1044,
 - 3. Piping: NPS 3/4, ASTM B 88, Type L; copper, water tubing.
 - 4. Cabinet: Surface-mounting steel box with stainless-steel cover.
 - 5. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120-V ac power.
 - 6. Vacuum Breaker: ASSE 1001.
 - 7. Size Outlets: NPS 1/2.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
 - 1. Locate backflow preventers in same room as connected equipment or system.
 - 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device

attached to or under backflow preventer. Simple air breaks are not acceptable for this application.

- 3. Do not install bypass piping around backflow preventers.
- C. Install water regulators with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.
- D. Install balancing valves in locations where they can easily be adjusted.
- E. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
 - 1. Install thermometers and water regulators if specified.
 - 2. Install cabinet-type units recessed in or surface mounted on wall as specified.
- F. Install Y-pattern strainers for water on supply side of each control valve, water pressurereducing valve, solenoid valve, and pump.
- G. Install outlet boxes recessed in wall. Install 2-by-4-inch fire-retardant-treated-wood blocking wall reinforcement between studs. Fire-retardant-treated-wood blocking is specified in Division 06 Section "Rough Carpentry."
- H. Install water hammer arresters in water piping according to PDI-WH 201.
- I. Install air vents at high points of water piping.
- J. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.
- K. Install trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.
- B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - 1. Intermediate atmospheric-vent backflow preventers.
 - 2. Reduced-pressure-principle backflow preventers.
 - 3. Double-check backflow-prevention assemblies.

- 4. Carbonated-beverage-machine backflow preventers.
- 5. Water pressure-reducing valves.
- 6. Calibrated balancing valves.
- 7. Primary, thermostatic, water mixing valves.
- 8. Manifold, thermostatic, water-mixing-valve assemblies.
- 9. Primary water tempering valves.
- 10. Outlet boxes.
- 11. Supply-type, trap-seal primer valves.
- 12. Trap-seal primer systems.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and prepare test reports:
 - 1. Test each reduced-pressure-principle backflow preventer and double-check backflow-prevention assembly according to authorities having jurisdiction and the device's reference standard.
- B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.5 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Set field-adjustable flow set points of balancing valves.
- C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF DOCUMENT 22 1119

SECTION 22 1120 DOMESTIC WATER RECIRCULATION AND CHLORINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 150 psig, unless otherwise indicated.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control test reports.
- C. Operation and Maintenance Data: For domestic water piping to include in emergency, Operation and Maintenance Manuals.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. NSF Compliance:
 - 1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
 - 2. Comply with NSF 61, "Drinking Water System Components Health Effects; Sections 1 through 9."

PART 2 - DESIGN CRITERIA

2.1 System has been designed based on the following criteria:

- A. Fluid: Potable water
- B. Temperature:80°F
- C. Storage Tank:750,156 gallons, aboveground type
- D. Chlorination method: Recirculation
- E. Operational duty:24 hours
- F. Recirculation's per day: Three (3) times

- G. Chlorine demand:2 ppm
- H. Chlorination fluid: Sodium hypochlorite
- I. Chlorine solution strength: 12.5%
- J. Required recirculation flowrate:1,600 gpm
- K. Recirculation pump total dynamic head: 60 ft
- L. Required chlorination flowrate:1.55 gph (37 gpd)
- M. Recirculation pipe size: 10.00" discharge/12" suction
- N. Recirculation pipe material: PVC schedule 80
- O. Recirculation pipe velocity: 5.65 fps maximum
- P. Recirculation friction factor:0.93 ft / 100 ft maximum
- Q. Electrical Classification: Non-classified (TEFC / NEMA 4X)
- R. Main Electrical Feeder: 3 / 60 / 460 VAC
- S. Automatic Control: By integral electrical panel at skid
- T. Installation: Outdoor

2.2 BASIS OF DESIGN

- A. To furnish one (1) skid-mounted simplex potable water chlorination system based on recirculation method for a 750,156 gallons aboveground type storage tank and requires three (3) cycles per day resulting in a recirculation flowrate of 1600 gpm. The recirculation of potable water will be performed by a single stage end suction close-coupled centrifugal pump sized for 1600 gpm @ 60 ft TDH with a 40 HP motor operating at 1200 rpm installed integral to the skid-mounted system. Typical for each water storage tank, total of three systems.
- B. The setpoint of the system is 2 ppm of residual chlorine demand using sodium hypochlorite 12.5% concentration. A chlorine sensor will monitor residual chlorine in the recirculation loop and the programmable logic controller (PLC) will modulate the operation of a metering pump to inject the required sodium hypochlorite 12.5% through a static mixer.
- C. The system to include a 140 gallons capacity double containment tank to storage the sodium hypochlorite with a low level switch in the main storage and leak detection switch in the double containment.
- D. The electrical panel for power and control purposes shall include a password protected (operator / supervisor levels) color touchscreen operator interface terminal (OIT) with the following information:
 - 1. Potable Water Recirculation Pump PWRP-01: operational mode (OFF / ON), status (OFF / ON), starter fault alarm, low power consumption

- 2. Metering Pump CLP-01: operation mode (OFF / AUTOMATIC), status (OFF / ON)
- 3. Free Chlorine: actual free chlorine reading (0 10 ppm units), free chlorine setpoint, low free chlorine alarm, high free chlorine alarm, free chlorine transmitter communication fault alarm
- 4. Sodium Hypochlorite Tank: low level alarm, leak detection alarm
- E. For all alarm conditions an audible alarm horn and the respective visual panel indication shall be energized. In order to silence the audible alarm horn, a RESET pushbutton needs to be pressed but the alarm visible indication shall continue energized until the situation is no longer present.
- F. For remote monitoring purpose the system shall include:
 - 1. One (1) dry-contact relay output for REMOTE GENERAL FAULT indication

2.3 SKID-MOUNTED EQUIPMENT DESCRIPTION

- A. One (1) skid-mounted simplex potable water chlorination system consisting of the following components:
- B. Potable Water Recirculation Pump (PWRP-01): One (1) Goulds single stage horizontal end suction close-coupled centrifugal pump model 3656-L, size 8x10-13, able to handle 1600 gpm @ 60 ft TDH, bronze fitted construction, 75.7% efficiency, 5.5 ft NPSHr, single conventional mechanical seal (carbon vs. ceramic faces), motor (40 HP, 1200 rpm, frame 364TCZ, TEFC enclosure, premium efficiency, 3 / 60 / 460 VAC, 49.8 FLA).
- C. Sodium Hypochlorite Metering Pump (CLP-01): One (1) Pulsafeeder electronic solenoid type metering pump model Pulsatron MP part number LME4TA-VTC1-500, 1.85 gph (44 gpd) maximum flowrate, 100 psig maximum discharge pressure, 4-20 mADC analog input, 100:1 stroke frequency turn-down ration, 10:1 stroke length turn-down ratio, 1/60/120 VAC power input, PVC pump head, PTFE-faced / CSPE backed diaphragm, PTFE seals, PTFE O-rings, ceramic check valves, PVC fittings, 3/8" OD x ¼" ID tubing connection, 6-button touch pad control, LCD 16-character dot matrix backlit multi-lingual display.
- D. 5-Function Valve: One (1) Pulsafeeder 5-function valve, 3/8" OD x ¼" ID tubing connections, PVDF body, Teflon O-ring, PTFE faced Hypalon diaphragm. It performs the following functions:
 - 1. Pressure Relief: Allows for relief of excessive pressure in discharge line to protect connections and tubing.
 - 2. Back Pressure: Maintains output reproducibility and allows metering into atmospheric discharge.
 - 3. Anti-Siphon: Prevents siphoning through the pump when point of injection is lower than the pump or into the suction line of another pump. Rated at total vacuum.
 - 4. Air Bleed: Used during priming to manually remove air from the pump head.
 - 5. Discharge Drain: Depressurize pump discharge line without loosening tubing or fittings. Protects the operator from chemical exposure.

- E. Potable Water Recirculation Isolation Valve (Butterfly Type): Bray butterfly valves 31 series, size 10.0", lug style, ductile iron epoxy coated body, ductile iron Nylon 11 coated (NDI) disc, 304 stainless steel stem, EPDM seat, manual operator gear operator type, handwheel in ductile iron construction.
- F. Potable Water Auxiliary Isolation Valve (Ball Style): Asahi True-Union ball valves type 21, size 0.50", PVC body construction, PTFE backed with EPDM seats, EPDM seals, socket process connections, manual operator lever type.
- G. Sodium Hypochlorite Isolation Valve (Ball Style): Asahi True-Union ball valves type 21, PVC body construction, PTFE backed with Viton seats, Viton seals, socket process connections, manual operator lever type.
- H. Potable Water Recirculation Check Valve: Bray Rite double door type check valve model D1015DEZNSF, size 10.0", wafer style, ductile iron body, stainless steel disc, stainless steel shaft, EPDM seat, stainless steel spring.
- I. Sodium Hypochlorite Check Valve: Asahi True-Union ball type check valve, size ½", socket connections, PVC body construction, Viton seats.
- J. Potable Water Recirculation Flexible Connector: PROCO single sphere flexible connector model 240-AV/NN, 10.0" (D) x 10.0" (L), galvanized steel flanged connections, EPDM elastomers.
- K. Potable Water Pressure Indicator: Wika pressure indicators model 213.53, 0–60 psig range, 2.5" dial diameter with glycerine filled, stainless steel case, bronze internals, ¼" MNPT process connection.
- L. Sodium Hypochlorite Pressure Indicator: Cole Parmer pressure indicator with chemical seal model GY-68000-21, 0–160 psig range, 2.5" dial diameter with glycerine filled, PVDF case, PVDF body, PTFE diaphragm, 316 stainless steel bourdon tube, ½" FNPT process connection.
- M. Static Mixer: KOFLO static mixer model 10-80-4-3.2R(3)-9.I(.50), 10.00" ANSI class 150# flanged connections, 78.00" overall length, PVC schedule 80 housing, three (3) PVC removable low pressure loss design mixing elements, 3.9 psi pressure drop handling 1389 gpm of potable water, (1) ½" FNPT chemical injection port. Includes one (1) KOFLO QP-.5-6.75-V injection quill, ½" MNPT x ½" FNPT, 6.75" stinger insertion length with 45° beveled tip, integrated check valve with Viton seal and corrosion resistant Hastelloy C-276 spring, ceramic ball and 5 psi cracking pressure.
- N. Sodium Hypochlorite Tank: One (1) Chem-Tainer double containment tank with cover model TC3345DC, 140 gallons capacity, 1.9 SG molded linear HDLPE construction, 33" (OD) x 45" (OAH) tank dimensions, (1) 8" access cover.
- O. Level Switch (Sodium Hypochlorite Tank Low Level): One (1) Flowline buoyancy type level switch model LV10-1301, 4.3" insertion length, ± 0.08" accuracy, ± 0.04" repeatability, ¾" MNPT process connection, 0.8 minimum specific gravity service, polypropylene sensor construction, polypropylene cable jacket construction, NEMA 6 (IP68) rating, (1) SPDT reed contact, NO / NC selectable contact output, 3-conductor #22 AWG / shielded cable 10 ft long, general purpose classification, PVC schedule 80 level sensor extension, NEMA 4X junction box in polypropylene construction, ½" FNPT conduit connection.

- P. Level Switch (Sodium Hypochlorite Tank Spill Containment): One (1) Flowline buoyancy type level switch model LV10-1301, 4.3" insertion length, ± 0.08" accuracy, ± 0.04" repeatability, ¾" MNPT process connection, 0.8 minimum specific gravity service, polypropylene sensor construction, polypropylene cable jacket construction, NEMA 6 (IP68) rating, (1) SPDT reed contact, NO / NC selectable contact output, 3-conductor #22 AWG / shielded cable 10 ft long, general purpose classification, PVC schedule 80 level sensor extension, NEMA 4X junction box in polypropylene construction, ½" FNPT conduit connection.
- Q. Free Chlorine Instrumentation: One (1) chlorine instrumentation package consisting of:
 - 1. One (1) Endress + Hauser analytical transmitter model Liquiline CM442-AAM2A1FA11A, (1) free chlorine measurement / (1) pH measurement, (2) 4-20 mADC analog output, NEMA 4X enclosure, 1/60/120 VAC power supply.
 - 2. One (1) Endress + Hauser flow assembly for sensors model Flowfit CCA250-M1
 - 3. One (1) Endress + Hauser free chlorine sensor model Memosens CCS51D-AA11AD, 0 – 5 ppm range
 - 4. One (1) Endress + Hauser pH sensor model Memosens CPS31D-7AC21, 0 10 pH range
- R. Electric Panel: One (1) electric panel for power and control purposes consisting of:
 - 1. (1) NEMA 4X enclosure, 304 stainless steel construction, surface-mounted style
 - 2. (1) main power distribution block with cover
 - 3. (1) 460/120 VAC control transformer
 - 4. (1) 2 poles / 2 amps miniature circuit breaker for control transformer
 - 5. (1) 1 pole / 4 amps miniature circuit breaker for 120 VAC circuit
 - 6. (1) IEC magnetic starter with adjustable overload for potable water recirculation pump PWRP-01, sized for 40 HP / 3 / 60 / 460 VAC
 - 7. (1) 2 pole / 2 amps miniature circuit breaker for metering pump CLP-01
 - 8. (1) 24 VDC power supply
 - 9. (1) Allen Bradley programmable logic controller (PLC) model MicroLogix 1400, Ethernet/IP communication port
 - 10. (1) door-mounted Allen Bradley operator interface terminal (OIT) model PanelView 800, 7" TDT color touchscreen
 - 11. (1) door-mounted maintained contact twist-to-release pushbutton for SYSTEM STOP
 - 12. (1) door-mounted 2-position maintained contact selector switch for PWRP-01 OFF / ON operational mode

- 13. (1) door-mounted 2-position maintained contact selector switch for CLP-01 OFF / AUTOMATIC operational mode
- 14. (1) dry-contact relay output for remote GENERAL FAULT indication
- 15. (1) audible alarm horn
- 16. (1) set of numbered terminal contacts

2.4 SKID DETAILS

- A. PIPING
 - 1. Potable Water: PVC schedule 80 construction, (1) 10.00" ANSI Class 150# flanged for potable water recirculation from storage tank, (1) 10.00" ANSI Class 150# flanged connection potable water recirculation return to storage tank
 - 2. Sodium Hypochlorite: PVC schedule 80 construction, (1) 0.50" FNPT for discharge of metering pump to injection at the inline static mixer

B. STRUCTURAL FRAME

- 1. Carbon steel structural wide flange beams ASTM A36 and carbon steel structural angles ASTM A36, (4) lifting lugs, (4) anchor pads; sized for the equipment loads
- 2. One (1) coat of PPG Amerlock penetrating epoxy primer sealer
- 3. One (1) coat of PPG Amerlock 2 aluminum epoxy mastic coating
- 4. One (1) coat of PPG Amercoat 450HS gloss aliphatic polyurethane topcoat
- C. ELECTRICAL CONDUITS
 - 1. Rigid hot-dip galvanized steel conduits, heavy duty PVC coated interlocked flexible metal liquid tight conduits for motors and instrumentation, general purpose area classification
- D. SYSTEM MANUFACTURER
 - 1. ENGINEER PARTS AND SERVICES (EPS): MR. JOSE MESTRES, 787-883-8880
- E. START-UP & TRAINING SERVICES
 - Start-up is required to activate the warranty of the system. A minimum notice of two

 weeks is required to schedule the start-up. The system should be set in place
 with all utilities connected before the start-up. The system shall be run to
 demonstrate its proper operation and the operational training to the group of
 persons coordinated by the customer.

END OF DOCUMENT 22 1120

SECTION 22 1121 DOMESTIC WATER BOOSTER PUMP

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 150 psig, unless otherwise indicated.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control test reports.
- C. Operation and Maintenance Data: For domestic water piping to include in emergency, Operation and Maintenance Manuals.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. NSF Compliance:
 - 1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
 - Comply with NSF 61, "Drinking Water System Components Health Effects; Sections 1 through 9."

1.5 DESIGN CRITERIA

- A. System shall be designed based on the following criteria:
- B. Fluid: Potable water, 85 °F temperature
- C. Required total capacity: 330 gpm
- D. Required system's discharge pressure: 140 psig
- E. Number of centrifugal pumps: Three (3) units
- F. Required flowrate per pump:110 gpm
- G. Required total dynamic head per pump: 323.4 ft

TLC Engineering Solutions

Project No. 121505 Domestic Water Booster Pump Section 22 1121 - 1
- H. Piping: 304 stainless steel schedule 10 ASTM A312
- I. Control strategy: Variable speed using one (1) 4-20 mADC pressure transmitter in the common discharge manifold as the main process variable.

1.6 BASIS OF DESIGN

- A. To furnish one (1) skid-mounted triplex pump booster system for potable water service. The objective of the system is to maintain a constant pressure of approximately 140 psig. The total maximum system capacity of 330 gpm will be handled by three (3) identical pumps operating simultaneously.
- B. The common discharge manifold includes an analog pressure transmitter. A PLC control unit will compare the pressure setting with the transmitter feedback and will regulate the pressure of the system by varying the speed of the pump(s). The control system will adjust the kilowatt power delivered and used by any pump operating to match the system flow rate and pressure requirement at any time. The system will monitor the KW requirement of the motor and will determine when one (1), two (2) or three (3) pumps are required to provide the system's demand. Lag pump(s) will ramp speed up to operating speed of the lead pump and then increase or reduce as necessary. Pumps operating in parallel will always operate at the same speed. Once the pressure of the system is stabilized and the RPM and KW measures are near the minimum for certain amount of time the lag pump(s) will shut down until one pump provides system demand
- C. Pumps will alternate automatically based on cycles of operation, operational time or a fault associated to the pump(s) in operation whenever the HAND / OFF / AUTOMATIC selector switches are in automatic mode.
- D. The suction manifold includes an analog pressure transmitter to protect the system against dry run conditions. The system is connected to three (3) aboveground storage tanks (flooded suction) and each tank includes.
- E. The electrical panel (power & control purposes) includes a password protected operator interface terminal (OIT) the following features:
 - 1. Main Screen: to show pumps status (OFF / ON / SATND-BY / FAULT, SPEED), suction pressure reading (psig units), discharge pressure reading (psig units), discharge pressure setpoint (psig units)
 - 2. Storage Tank: level reading (0-100% units), outlet automatic valve status (open / close), per tank
 - 3. Status Screen: shows status of the possible alarms (VFD fault, low current consumption, phase loss, low suction pressure, suction pressure transmitter communication fault, low discharge pressure, high discharge pressure, discharge pressure transmitter communication fault, system stop, tank low low level alarm, tank low level warning, tank high level warning, tank level transmitter communication fault, tank discharge valve position fault).
 - 4. Trend Screen: shows discharge pressure trend vs. time
 - 5. Preventive Maintenance Screen: shows hour-meters and maintenance warnings with password protected reset function.
 - 6. Setpoints Screen: shows the setpoints for discharge pressure, low suction pressure alarm, low discharge pressure alarm, high discharge pressure alarm, low current consumption alarm, pre-set speed for manual operation, tank low low level alarm,

tank low level warning, tank high level warning. Password protected for supervisor level.

7. For all above alarm conditions a visual and audible signal will be energized. To silence the audible alarm horn a SILENCER pushbutton is included but the alarm message will be energized until the associated situation is no longer present.

1.7 SKID-MOUNTED EQUIPMENT DESCRIPTION

One (1) skid-mounted triplex potable water booster pump system with the following components:

- A. Centrifugal Pump: Three (3) Goulds end-suction multi-stage centrifugal pumps model 33SV42GL4F66, four (4) stages, able to handle 110 gpm @ 323.4 ft TDH, 2.5" ANSI Class 125# flanged suction / discharge connections, cast iron construction with 316 stainless steel impellers, 71.2% efficiency, 7.1 ft NPSHr, 13.8 BHP at design condition, 17.3 BHP at maximum run-out condition, single conventional mechanical seal (carbon vs. silicon carbide faces, EPR elastomers, 316 stainless steel metallic parts), motor (20 HP, 3500 rpm, TEFC enclosure, premium efficiency, inverter duty, 3 / 60 / 460 VAC / 23.0 FLA).
- B. Isolation Valve (Suction of Pump): Three (3) Bray 31 series butterfly valve, size 3.0", lug style, ductile iron epoxy coated body, ductile iron Nylon 11 coated (NDI) disc, 416 stainless steel stem, EPDM seat, manual operator 01 series lever type.
- C. Isolation Valve (Discharge of Pump): Three (3) Bray 31 series butterfly valve, size 3.0", lug style, ductile iron epoxy coated body, ductile iron Nylon 11 coated (NDI) disc, 416 stainless steel stem, EPDM seat, manual operator 01 series lever type.
- D. Isolation Valve (Hydro-Pneumatic Tank): One (1) Flow-Tek 70 series ball valve, size 1.50", FNPT process connections, 316 stainless steel body, 316 stainless steel ball, RPTFE seats, manual operator lever type.
- E. Check Valve (Discharge of Pump): Three (3) Bray Rite double disc type check valves, size 3.0", wafer style, ductile iron body, 316 stainless steel disc, 316 stainless steel stem, EPDM seats.
- F. Flexible Connector (Suction of Pump): Three (3) PROCO single sphere flexible connectors model 240-AV/EE, 3.0" (D) x 6.0" (OAL), ANSI Class 150# flanged process connections, EPDM elastomer.
- G. Flexible Connector (Discharge of Pump): Three (3) PROCO single sphere flexible connectors model 240-AV/EE, 3.0" (D) x 6.0" (OAL), ANSI Class 150# flanged process connections, EPDM elastomer.
- Pressure Indicator (Common Suction Manifold): One (1) Wika pressure indicator model 233.53, 2.5" dial diameter, 0 30 psig range, stainless steel case, stainless steel internals, ¼" MNPT lower mount process connection, glycerine filled, 316 stainless steel isolation ball valve with manual operator lever type.
- Pressure Indicator (Discharge of Pump): Three (3) Wika pressure indicators model 233.53, 2.5" dial diameter, 0-300 psig range, stainless steel case, stainless steel internals, ¼" MNPT lower mount process connection, glycerine filled, 316 stainless steel isolation ball valve with manual operator lever type.
- J. Pressure Indicator (Common Discharge Manifold): One (1) Wika pressure indicator model 233.53, 2.5" dial diameter, 0-300 psig range, stainless steel case, stainless steel internals,

1/4" MNPT lower mount process connection, glycerine filled, 316 stainless steel isolation ball valve with manual operator lever type.

- K. Pressure Transmitter (Common Suction Manifold): One (1) Wika analog pressure transmitter model UPT-20, 0-30 psig range, 316 stainless steel wetted parts, (1) 4-20 mADC analog output, ½" MNPT process connection, 316 stainless steel isolation ball valve with manual operator lever type.
- L. Pressure Transmitter (Common Discharge Manifold): One (1) Wika analog pressure transmitter model UPT-20, 0-300 psig range, 316 stainless steel wetted parts, (1) 4-20 mADC analog output, ½" MNPT process connection, 316 stainless steel isolation ball valve with manual operator lever type.
- M. Electrical Panel: One (1) electrical panel for power and control purposes with:
 - (1) NEMA 4 enclosure, 60" (H) x 37" (W) x 16" (D), ANSI-61 gray powder coated steel construction, wall / surface mounted style, suitable for flanged type main disconnect switch
 - 2. (1) panel-mounted filtered exhaust fan, 550 cfm, 3 / 60 / 460 VAC
 - 3. (1) main power distribution block with cover
 - 4. (1) 500 VA 460/120 VAC control transformer
 - 5. (1) 460 VAC phase monitor
 - 6. (2) 24 VDC power supply
 - 7. (1) 8-port unmanaged Ethernet/IP switch
 - 8. (1) 2 poles / 2 amps miniature circuit breaker for control transformer
 - 9. (1) 3 poles / 2 amps miniature circuit breaker for phase monitor
 - 10. (1) 1 pole / 4 amps miniature circuit breaker for 120 VAC circuit
 - 11. (1) 3 poles / 80 amps main molded case circuit breaker with door-mounted flange type lockable disconnect switch for LOTO purposes
 - 12. (3) motor circuit breaker with door-mounted rotary-type lockable disconnect switch for LOTO purposes, sized for 20 HP (3 / 60 / 460 VAC) motor
 - 13. (3) Allen Bradley variable frequency drive (VFD) model PowerFlex 525 sized for 20 HP (3 / 60 / 460 VAC), with integral alphanumeric human interface module (HIM), Ethernet/IP communication module
 - 14. (1) Allen Bradley programmable logic controller (PLC) model CompactLogix L16, Ethernet/IP communication port, auxiliary I/O modules
 - 15. (1) Allen Bradley operator interface terminal (OIT) model Panel View Plus 7 standard, 10.0" TFT color touchscreen, Ethernet/IP communication module
 - 16. (1) door-mounted maintained contact mushroom type twist-to-release pushbutton for SYSTEM STOP
 - 17. (3) door-mounted 3-position maintained contact selector switch for PUMP HAND / OFF / AUTOMATIC operational mode
 - 18. (1) panel-mounted tower light, (1) green beacon for SYSTEM ON local indication, (1) red beacon for GENERAL FAULT local indication
 - 19. (1) dry-contact relay output for remote SYSTEM ON indication

- 20. (1) dry-contact relay output for remote GENERAL FAULT indication
- 21. (1) audible alarm horn
- 22. (1) set of numbered terminal contacts, wire duct, wiring and phenolic labels
- N. Hydro-Pneumatic Tank: One (1) Wessels pre-charged hydro-pneumatic tank model FXA-700, 185 gallons overall capacity, 30" (D) x 80" (OAH), 1.50" FNPT process connection, carbon steel shell, heavy duty butyl replaceable bladder, ASME 200 psig coded & stamped, 240 °F maximum design temperature,

1.8 SYSTEM MANUFACTURER

A. ENGINEER PARTS AND SERVICES (EPS): MR. JOSE MESTRES, 787-883-8880

1.9 START-UP & TRAINING SERVICES

A. Start-up is required to activate the warranty of the system. A minimum notice of two (2) weeks is required to schedule the start-up. The system should be set in place with all utilities connected before the start-up. The system shall be run to demonstrate its proper operation and the operational training to the group of persons coordinated by the customer.

1.10 WARRANTY

A. Engineered Parts & Services, Inc. warrants our systems to be free of defects in design, material and workmanship under normal use for twelve (12) months from date of start-up or eighteen (18) months from date of shipment whatever occurs first.

END OF DOCUMENT 22 1120

SECTION 22 1316 SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following for soil, waste, and vent piping inside the building:
 - 1. Pipe, tube, and fittings.

1.3 DEFINITIONS

A. PVC: Polyvinyl chloride plastic.

1.4 **PERFORMANCE REQUIREMENTS**

A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated: Soil, Waste, and Vent Piping: 10-foot head of water

1.5 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.
- B. LEED Submittal:
 - 1. Product Data for Credit EQ4.1: For solvent cements and adhesive primers, including printed statement of VOC content.
- C. Field quality-control inspection and test reports.

1.6 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. All cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI) and be listed by NSF International.
- C. Comply with NSF 14, "Plastic Piping System Components and Related Materials", for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste and vent piping; "NSF-drain" for plastic drain piping: "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 74, Service class. Marked with CISPI collective trademark and be listed by NSF International.
- B. Gaskets: ASTM C 564, rubber.

2.4 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: CISPI 301. Marked with CISPI collective trademark and be listed by NSF International.
- B. Shielded Couplings: ASTM C 1277 and FM 1680 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.
 - 1. Heavy-Duty, Shielded, Stainless-Steel Couplings: With stainless-steel shield, stainless-steel bands and tightening devices, and ASTM C 564, rubber sleeve.
 - a. Manufacturers:
 - 1) Clamp-All Corp.
 - 2) Husky.
 - 3) Anaco.

2.5 COPPER TUBE AND FITTINGS

- A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.
 - 1. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
- B. Hard Copper Tube: ASTM B 88, Types L and M, water tube, drawn temper.
 - 1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 - 2. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
 - 3. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-andsocket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.6 PVC PIPE AND FITTINGS

A. Solid Wall PVC Pipe: ASTM D2665, drain, waste and vent.

- 1. PVC Socket Fittings: ASTM D2665, socket type made to ASTM D3311, drain, waste and vent patterns.
- B. Solvent Cement and Adhesive Primer:
 - 1. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.7 SPECIAL PIPE FITTINGS

- A. Shielded Nonpressure Pipe Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - 1. Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
 - b. Mission Rubber Co.
- B. Expansion Joints: Two or three-piece, ductile-iron assembly consisting of telescoping sleeve(s) with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Select and assemble components for expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
 - 1. Manufacturers:
 - a. EBAA Iron Sales, Inc.
 - b. Romac Industries, Inc.
- C. Wall-Penetration Fittings: Compound, ductile-iron coupling fitting with sleeve and flexing sections for up to 20-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
 - 1. Manufacturers: SIGMA Corp.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.

- B. Aboveground, soil and waste piping shall be the following:
 - 1. Hubless cast-iron soil pipe and fittings heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.
 - 2. Dissimilar Pipe-Material Couplings: Shielded nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.
- C. Aboveground, vent piping shall be the following:
 - 1. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.
 - 2. Copper DWV tube, copper drainage fittings, and soldered joints:
 - a. Option for Vent Piping, NPS 2-1/2 and NPS 3-1/2: Hard copper tube, Type M; copper pressure fittings; and soldered joints.
 - 3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.
- D. Underground, soil, waste, and vent piping shall be the following:
 - 1. Service class, cast-iron soil piping; gaskets; and gasketed joints.
 - 2. Solid Wall PVC, PVC socket fittings and solvent cemented joints.
 - 3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

3.3 PIPING INSTALLATION

- A. Sanitary sewer piping outside the building is specified in Division 22 Section "Facility Sanitary Sewers."
- B. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- C. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.
- D. Install underground, ductile-iron, special pipe fittings according to AWWA C600.
- E. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 22 Section "Common Work Results for Plumbing."
- F. Install wall-penetration fitting at each service pipe penetration through foundation wall. Make installation watertight.
- G. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

- H. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- I. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- J. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
 - 1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
 - 2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
 - 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- K. Install engineered soil and waste drainage and vent piping systems as follows:
 - 1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
- L. Sleeves are not required for cast-iron soil piping passing through concrete slabs-ongrade if slab is without membrane waterproofing.
- M. Install underground PVC soil waste and drainage piping according to ASTM D2665.
- N. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.4 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- B. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- C. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
- D. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.
- E. PVC Non-Pressure Piping Joints: Join according to ASTM D2665.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:
 - 1. Vertical Piping: MSS Type 8 or Type 42 clamps.
 - 2. Install individual, straight, horizontal piping runs according to the following:

a.100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers. b.Longer than 100 Feet: MSS Type 43, adjustable roller hangers. c.Longer than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.

- 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
- 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
 - 2. NPS 3: 60 inches with 1/2-inch rod.
 - 3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
 - 4. NPS 6: 60 inches with 3/4-inch rod.
 - 5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.
- F. Install supports for vertical cast-iron soil piping every 15 feet.
- G. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4: 72 inches with 3/8-inch rod.
 - 2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 - 3. NPS 2-1/2: 108 inches with 1/2-inch rod.
 - 4. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
 - 5. NPS 6: 10 feet with 5/8-inch rod.
 - 6. NPS 8: 10 feet with 3/4-inch rod.
- H. Install supports for vertical copper tubing every 10 feet.
- I. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect drainage and vent piping to the following:
 - 1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
 - 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
 - 3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
 - 4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

3.7 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
 - 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or

manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.

- 5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
- 6. Prepare reports for tests and required corrective action.

3.8 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF DOCUMENT 22 1316

SECTION 22 1319 SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following sanitary drainage piping specialties:
 - 1. Backwater valves.
 - 2. Cleanouts.
 - 3. Floor drains.
 - 4. Trench drains.
 - 5. Roof flashing assemblies.
 - 6. Through-penetration firestop assemblies.
 - 7. Miscellaneous sanitary drainage piping specialties.
 - 8. Flashing materials.
 - 9. Grease interceptors.
 - 10. Oil interceptors.
 - 11. Solids interceptors.

1.3 DEFINITIONS

A. FRP: Fiberglass-reinforced plastic.

1.4 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 BACKWATER VALVES

- A. Horizontal, Cast-Iron Backwater Valves:
 - a. Josam Company; Josam Div.
 - b. Smith, Jay R. Mfr. Co.; Division of Smith Industries, Inc.

Project No. 121505 Sanitary Waste Piping Specialties Section 22 1319 - 1

- c. Zurn Plumbing Products Group; Specification Drainage Operation.
- 2. Standard: ASME A112.14.1.
- 3. Size: Same as connected piping.
- 4. Body: Cast iron.
- 5. Cover: Cast iron with bolted or threaded access check valve.
- 6. End Connections: Hub and spigot or hubless.
- 7. Type Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang closed.
- 8. Extension: ASTM A 74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.
- B. Drain-Outlet Backwater Valves:
 - a. Josam Company; Josam Div.
 - b. Smith, Jay R. Mfr. Co.; Division of Smith Industries, Inc.
 - c. Watts Drainage Products Inc.
 - d. Zurn Plumbing Products Group; Specification Drainage Operation.
 - 2. Size: Same as floor drain outlet.
 - 3. Body: Cast iron or bronze made for vertical installation in bottom outlet of floor drain.
 - 4. Check Valve: Removable ball float.
 - 5. Inlet: Threaded.
 - 6. Outlet: Threaded or spigot.

2.2 CLEANOUTS

- A. Exposed Metal Cleanouts:
 - a. Josam Company; Josam Div.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Watts Drainage Products Inc.
 - d. Zurn Plumbing Products Group; Specification Drainage Operation.
 - 2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
 - 3. Size: Same as connected drainage piping.
- B. Metal Floor Cleanouts:
 - a. Josam Company; Josam Div.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Watts Drainage Products Inc.
 - d. Zurn Plumbing Products Group; Specification Drainage Operation.
 - 2. Standard: ASME A112.36.2M for adjustable housing cleanout.
 - 3. Size: Same as connected branch.
- C. Cast-Iron Wall Cleanouts:
 - a. Josam Company; Josam Div.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Watts Drainage Products Inc.
 - d. Zurn Plumbing Products Group; Specification Drainage Operation.

- 2. Standard: ASME A112.36.2M. Include wall access.
- 3. Size: Same as connected drainage piping.

2.3 FLOOR DRAINS

- A. Cast-Iron Floor Drains:
 - a. Josam Company; Josam Div.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Watts Drainage Products Inc.
 - d. Zurn Plumbing Products Group; Specification Drainage Operation.
 - 2. Standard: ASME A112.6.3.
 - 3. Body Material: Gray iron.
 - 4. Outlet: Bottom.
- B. Stainless-Steel Floor Drains:
 - a. Josam Company; Blucher-Josam Div.
 - b. Josam Company; Josam Div.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Watts Drainage Products Inc.
 - e. Zurn Plumbing Products Group; Specification Drainage Operation.
 - 2. Standard: ASME A112.3.1 or ASME A112.6.3.
 - 3. Outlet: Bottom.
 - 4. Top or Strainer Material: Stainless steel.

2.4 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

- A. Hub Drains:
 - 1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-andspigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
 - 2. Size: Same as connected waste piping with increaser fitting of size indicated.
- B. Deep-Seal Traps:
 - 1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
 - 2. Size: Same as connected waste piping:
 - a. NPS 2: 4-inch- minimum water seal.
 - b. NPS 2-1/2 and Larger: 5-inch- minimum water seal.
- C. Floor-Drain, Trap-Seal Primer Fittings:
 - 1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trapseal primer valve connection.
 - 2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

- D. Air-Gap Fittings:
 - 1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
 - 2. Body: Bronze or cast iron.
 - 3. Inlet: Opening in top of body.
 - 4. Outlet: Larger than inlet.
 - 5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.
- E. Sleeve Flashing Device:
 - 1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 1 inch above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
 - 2. Size: As required for close fit to riser or stack piping.
- F. Stack Flashing Fittings:
 - 1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
 - 2. Size: Same as connected stack vent or vent stack.
- G. Expansion Joints:
 - 1. Standard: ASME A112.21.2M.
 - 2. Body: Cast iron with bronze sleeve, packing, and gland.
 - 3. End Connections: Matching connected piping.
 - 4. Size: Same as connected soil, waste, or vent piping.

2.5 FLASHING MATERIALS

- A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:
 - 1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
 - 2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.
 - 3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.
- B. Fasteners: Metal compatible with material and substrate being fastened.
- C. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
- D. Solder: ASTM B 32, lead-free alloy.
- E. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

2.6 MOTORS

- A. General requirements for motors are specified in Division 22 Section "Common Motor Requirements for Plumbing Equipment."
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - 2. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.
- C. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 - 1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate at each change in direction of piping greater than 45 degrees.
 - 3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 - 4. Locate at base of each vertical soil and waste stack.
- D. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- E. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- F. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 - 1. Position floor drains for easy access and maintenance.
 - 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
 - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
 - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
 - 3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.

- 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- G. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface, unless otherwise indicated.
- H. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
- I. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.
- J. Install through-penetration firestop assemblies at floor penetrations.
- K. Assemble hub drain fittings and install with top of hub 1 inch above floor.
- L. Install deep-seal traps on floor drains and other waste outlets, if indicated.
- M. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
 - 1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
 - 2. Size: Same as floor drain inlet.
- N. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- O. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
- P. Install vent caps on each vent pipe passing through roof.
- Q. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
- R. Install oil interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing. Coordinate oil-interceptor storage tank and gravity drain with Division 23 Section "Facility Fuel-Oil Piping."
- S. Install wood-blocking reinforcement for wall-mounting-type specialties.
- T. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.
- U. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.

- C. Oil Interceptors: Connect inlet, outlet, vent, and gravity drawoff piping to unit; flow-control fitting and vent to unit inlet piping; and gravity drawoff and suction piping to oil storage tank.
- D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FLASHING INSTALLATION

- A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
 - 1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
 - 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
 - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
 - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.
- E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 07 Section "Sheet Metal Flashing and Trim."
- F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.
- G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 PROTECTION

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF DOCUMENT 22 1319

SECTION 22 1413 FACILITY STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following storm drainage piping inside the building:
 - 1. Pipe, tube, and fittings.
 - 2. Special pipe fittings.

1.3 **DEFINITIONS**

A. TPE: Thermoplastic elastomer.

1.4 **PERFORMANCE REQUIREMENTS**

- A. Components and installation shall be capable of withstanding the following minimum working-pressure, unless otherwise indicated:
 - 1. Storm Drainage Piping: 10-foot head of water.
 - 2. Condensate, Force-Main Piping: 150 psig.

1.5 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.
- B. Shop Drawings:
 - 1. Controlled-Flow Storm Drainage System: Include calculations, plans, and details.
- C. Field quality-control inspection and test reports.

1.6 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. All cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI) and be listed by NSF International.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 74, Service class(es). Marked with CISPI collective trademark and be listed by NSF International.
- B. Gaskets: ASTM C 564, rubber.
- C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.4 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. Shielded Couplings: ASTM C 1277 and FM1680 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.
 - 1. Heavy-Duty, Shielded, Stainless-Steel Couplings: With stainless-steel shield, stainless-steel bands and tightening devices, and ASTM C 564, rubber sleeve.
 - a. Manufacturers:
 - 1) ANACO.
 - 2) Clamp-All Corp.
 - 3) Ideal Div.; Stant Corp.
 - 4) Mission Rubber Co.
 - 5) Tyler Pipe; Soil Pipe Div.
- C. Rigid, Unshielded Couplings: ASTM C 1461, sleeve-type, reducing- or transition-type mechanical coupling molded from ASTM C 1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.
 - 1. Manufacturer: ANACO.

2.5 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade A or B, Standard Weight or Schedule 40, galvanized. Include ends matching joining method.
- B. Pressure Fittings:
 - Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, galvanized, seamless steel pipe. Include ends matching joining method.
 - 2. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with balland-socket, metal-to-metal, bronze seating surface; and female threaded ends.
 - 3. Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, standard pattern.
 - 4. Cast-Iron Flanges: ASME B16.1, Class 125.
 - 5. Cast-Iron, Flanged Fittings: ASME B16.1, Class 125, galvanized.

2.6 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Types L and M, water tube, drawn temper.
 - 1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 - 2. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
 - 3. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-andsocket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.7 PVC PIPE AND FITTINGS

- A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste and vent.
- B. Solvent Cement and Adhesive Primer:
 - 1. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Use PVC primer that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.8 SPECIAL PIPE FITTINGS

- A. Shielded Nonpressure Pipe Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - 1. Manufacturer: Cascade Waterworks Mfg. Co.
- B. Pressure Pipe Couplings: AWWA C219 metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
 - 1. Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
 - b. Dresser, Inc.; DMD Div.
 - c. EBAA Iron Sales, Inc.
 - d. Ford Meter Box Company, Inc. (The); Pipe Products Div.
 - e. JCM Industries, Inc.
 - f. Romac Industries, Inc.
 - g. Smith-Blair, Inc.
 - h. Viking Johnson.
- C. Expansion Joints: Two or three-piece, ductile-iron assembly consisting of telescoping sleeve(s) with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Select and assemble components for expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
 - 1. Manufacturers:
 - a. EBAA Iron Sales, Inc.

Project No. 121505 Facility Storm Drainage Piping Section 22 1413 - 3

- b. Romac Industries, Inc.
- c. Star Pipe Products; Star Fittings Div.
- D. Wall-Penetration Fittings: Compound, ductile-iron coupling fitting with sleeve and flexing sections for up to 20-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
 - 1. Manufacturer: SIGMA Corp.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

- A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.
- B. Aboveground storm drainage piping NPS 6 and smaller shall be any of the following:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets and gasketed joints.
 - 2. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and coupled joints.
 - 3. Dissimilar Pipe-Material Couplings: Shielded nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.
- C. Aboveground, storm drainage piping NPS 8 and larger shall be any of the following:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets and gasketed joints.
 - 2. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and coupled joints.
 - 3. Dissimilar Pipe-Material Couplings: Shielded nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.
- D. Underground storm drainage piping NPS 6 and smaller shall be any of the following:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets and gasketed joints.
 - 2. Dissimilar Pipe-Material Couplings: Shielded nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.
 - 3. Solid-wall PVC pipe, PVC socket fittings and solvent-cemented joints.
- E. Underground, storm drainage piping NPS 8 and larger shall be any of the following:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets and gasketed.
 - 2. Dissimilar Pipe-Material Couplings: Shielded nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.
 - 3. Solid-wall PVC pipe, PVC socket fittings and solvent-cemented joints.
- F. Aboveground condensate force mains NPS 1-1/2 and NPS 2 shall be any of the following:
 - 1. Hard copper tube, Type L; copper pressure fittings; and soldered joints.
 - 2. Steel pipe, pressure fittings, and threaded joints.

- G. Aboveground condensate force mains NPS 2-1/2 and NPS 6 shall be any of the following:
 - 1. Hard copper tube, Type L; copper pressure fittings; and soldered joints.
 - 2. Steel pipe, pressure fittings, and threaded joints.

3.3 PIPING INSTALLATION

- A. Storm sewer and drainage piping outside the building are specified in Division 33 Section "Storm Utility Drainage Piping."
- B. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- C. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers. Cleanouts are specified in Division 22 Section "Storm Drainage Piping Specialties."
- D. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.
- E. Install underground, steel, force-main piping.
- F. Install underground, ductile-iron, force-main piping according to AWWA C600. Install buried piping inside building between wall and floor penetrations and connection to storm sewer piping outside building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
- G. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."
- H. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 22 Section "Common Work Results for Plumbing."
- I. Install wall-penetration fitting system at each service pipe penetration through foundation wall. Make installation watertight.
- J. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- K. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- L. Install storm drainage piping at the following minimum slopes, unless otherwise indicated:
 - 1. Building Storm Drain: 1 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
 - 2. Horizontal Storm-Drainage Piping: 2 percent downward in direction of flow.

- M. Install force mains at elevations indicated.
- N. Install engineered controlled-flow storm drainage piping in locations indicated.
- O. Sleeves are not required for cast-iron soil piping passing through concrete slabs-ongrade if slab is without membrane waterproofing.
- P. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- Q. Install PVC storm drainage piping according to ASTM D 2665.
- R. Install underground PVC storm drainage according to ASTM D 2321.

3.4 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- B. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- C. Hub-and-Spigot, Cast-Iron Soil Piping Calked Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
- D. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.
- E. Grooved Joints: Cut groove ends of pipe and assemble grooved ends of pipes, groovedend fittings, and grooved-end-piping couplings according to AWWA C606.
- F. PVC Nonpressure piping Joints: Join piping according to ASTM D 2665.

3.5 VALVE INSTALLATION

- A. General valve installation requirements are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
- B. Shutoff Valves: Install shutoff valve on each sump pump discharge.
 - 1. Install gate or full-port ball valve for piping NPS 2 and smaller.
 - 2. Install gate valve for piping NPS 2-1/2 and larger.
- C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sump pump discharge.
- D. Backwater Valves: Install backwater valves in piping subject to backflow.
 - 1. Horizontal Piping: Horizontal backwater valves. Use normally closed type, unless otherwise indicated.
 - 2. Install backwater valves in accessible locations.
 - 3. Backwater valve are specified in Division 22 Section "Storm Drainage Piping Specialties."

3.6 HANGER AND SUPPORT INSTALLATION

- A. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:
 - 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs: According to the following:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
- D. Support vertical piping and tubing at base and at each floor.
- E. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
 - 2. NPS 3: 60 inches with 1/2-inch rod.
 - 3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
 - 4. NPS 6: 60 inches with 3/4-inch rod.
 - 5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.
 - 6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
- G. Install supports for vertical cast-iron soil piping every 15 feet.
- H. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4: 84 inches with 3/8-inch rod.
 - 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 - 3. NPS 2: 10 feet with 3/8-inch rod.
 - 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
 - 5. NPS 3: 12 feet with 1/2-inch rod.
 - 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
 - 7. NPS 6: 12 feet with 3/4-inch rod.
 - 8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

TLC Engineering Solutions

Project No. 121505 Facility Storm Drainage Piping Section 22 1413 - 7

- I. Install supports for vertical steel piping every 15 feet.
- J. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4: 72 inches with 3/8-inch rod.
 - 2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 - 3. NPS 2-1/2: 108 inches with 1/2-inch rod.
 - 4. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
 - 5. NPS 6: 10 feet with 5/8-inch rod.
 - 6. NPS 8: 10 feet with 3/4-inch rod.
- K. Install supports for vertical copper tubing every 10 feet.
- L. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect storm drainage piping to roof drains and storm drainage specialties.
- D. Connect force-main piping to the following:
 - 1. Storm Sewer: To exterior force main or storm manhole.
 - 2. Sump Pumps: To sump pump discharge.

3.8 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

- 2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
- 3. Test Procedure: Test storm drainage piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
- 4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
- 5. Prepare reports for tests and required corrective action.
- E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - 3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - 4. Prepare reports for tests and required corrective action.

END OF DOCUMENT 22 1413

SECTION 22 1423 STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 **RELATED DOCUMENTS**

Α. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.1 SUMMARY

- Α. This Section includes the following storm drainage piping specialties:
 - 1. Backwater valves.
 - 2. Cleanouts.
 - 3. Trench drains.
 - 4. Roof drains.

1.2 **SUBMITTALS**

Α. Product Data: For each type of product indicated.

1.3 QUALITY ASSURANCE

Drainage piping specialties shall bear label, stamp, or other markings of specified testing Α. agency.

1.4 COORDINATION

Α. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 **BACKWATER VALVES**

- Α. Horizontal, Cast-Iron Backwater Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - Smith, Jay R. Mfr. Co.; Division of Smith Industries, Inc. b.
 - Watts Drainage Products Inc. C.
 - d. Zurn Plumbing Products Group; Specification Drainage Operation.
 - 2. Standard: ASME A112.14.1.
 - Size: Same as connected piping.
 Body: Cast iron.

 - 5. Cover: Cast iron with bolted or threaded access check valve.
 - 6. End Connections: Hub and spigot or hubless.
 - 7. Type Check Valve: Removable, bronze, swing check, factory assembled to hang closed.

- 8. Extension: ASTM A 74, Service class; full-size, cast-iron, soil-pipe extension to fieldinstalled cleanout at floor; replaces backwater valve cover.
- B. Drain-Outlet Backwater Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. Smith, Jay R. Mfr. Co.; Division of Smith Industries, Inc.
 - c. Watts Drainage Products Inc.
 - d. Zurn Plumbing Products Group; Specification Drainage Operation.
 - 2. Size: Same as floor drain outlet.
 - 3. Body: Cast iron or bronze made for vertical installation in bottom outlet of floor drain.
 - 4. Check Valve: Removable ball float.
 - 5. Inlet: Threaded.
 - 6. Outlet: Threaded or spigot.

2.2 CLEANOUTS

- A. Metal Floor Cleanouts:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Watts Drainage Products Inc.
 - d. Zurn Plumbing Products Group; Specification Drainage Operation.
 - 2. Standard: ASME A112.36.2M for adjustable housing cleanout.
 - 3. Size: Same as connected branch.
 - 4. Type: Adjustable housing, cast-iron soil pipe with cast-iron ferrule.
 - 5. Body or Ferrule: Cast iron.
 - 6. Clamping Device: Required.
 - 7. Closure: Cast-iron plug.
 - 8. Adjustable Housing Material: Cast iron with threads.
 - 9. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
 - 10. Frame and Cover Shape: Round.
 - 11. Top Loading Classification: Heavy Duty.
 - 12. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
- B. Cast-Iron Wall Cleanouts:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Watts Drainage Products Inc.
 - d. Zurn Plumbing Products Group; Specification Drainage Operation.
 - 2. Standard: ASME A112.36.2M. Include wall access.

- 3. Size: Same as connected drainage piping.
- 4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
- 5. Closure: Countersunk cast-iron plug.
- 6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
- 7. Wall Access: Round, stainless-steel cover plate with screw.

2.3 TRENCH DRAINS

- A. Trench Drains:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Watts Drainage Products Inc.
 - d. Zurn Plumbing Products Group; Specification Drainage Operation.
 - 2. Standard: ASME A112.6.3 for trench drains.

2.4 ROOF DRAINS

- A. Cast Iron, Large Sump, General Purpose Roof Drains: (For use in areas where plans indicate Gravity System) -
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Watts Drainage Products Inc.
 - d. Zurn Plumbing Products Group; Specification Drainage Operation.
 - 2. Standard: ASME A112.21.2M.
 - 3. Pattern: Roof drain.
 - 4. Body Material: Cast iron.
 - 5. Dimensions of Body: 15" Diameter.
 - 6. Combination Flashing Ring and Gravel Stop: Required.
 - 7. Flow-Control Weirs: Required for overflow drains only.
 - 8. Outlet: Bottom.
 - 9. Dome Material: Cast iron.
 - 10. Extension Collars: Required.
 - 11. Underdeck Clamp: Required.
 - 12. Sump Receiver: Required.

2.5 FLASHING MATERIALS

- A. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.
- B. Fasteners: Metal compatible with material and substrate being fastened.
- C. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

- D. Solder: ASTM B 32, lead-free alloy.
- E. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 - 1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate at each change in direction of piping greater than 45 degrees.
 - 3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 - 4. Locate at base of each vertical soil and waste stack.
- C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- E. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface, unless otherwise indicated.
- F. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions. Roofing materials are specified in Division 07.
 - 1. Install roof-drain flashing collar or flange so that there will be no leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
 - 2. Position roof drains for easy access and maintenance.
- G. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
- H. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 FLASHING INSTALLATION

- A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
 - 1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.

- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
 - 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
 - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
 - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.
- E. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF DOCUMENT 22 1423

SECTION 22 1429 SUMP PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Submersible sump pumps.
 - 2. Sump-pump basins and basin covers.
 - 3. Packaged drainage-pump units.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Wiring Diagrams: For power, signal, and control wiring.
- C. Operation and Maintenance Data: For pumps and controls, to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Retain shipping flange protective covers and protective coatings during storage.
- B. Protect bearings and couplings against damage.
- C. Comply with pump manufacturer's written rigging instructions for handling.

PART 2 - PRODUCTS

2.1 SUBMERSIBLE SUMP PUMPS

- A. Submersible, Fixed-Position, Single-Seal Sump Pumps:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bell & Gossett Domestic Pump; ITT Corporation.
 - b. Goulds Pumps; ITT Corporation.

Project No. 121505 Sump Pumps Section 22 1429 - 1

- c. Grundfos Pumps Corp.
- d. Little Giant Pump Co.
- e. Weil Pump Company, Inc.
- 2. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhungimpeller, centrifugal sump pump as defined in HI 1.1-1.2 and HI 1.3.
- 3. Impeller: Statically and dynamically balanced, ASTM A 48/A 48M, Class No. 25 A cast iron design for clear wastewater handling, and keyed and secured to shaft.
- 4. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings.
- 5. Seal: Mechanical.
- 6. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
- 7. Controls:
 - a. Enclosure: NEMA 250, Type 1 for indoor use.
 - b. Switch Type: Mechanical-float, mercury-float type, or pressure type in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
 - c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
 - d. High-Water Alarm: Cover mounted, compression probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
- 8. Control-Interface Features:
 - a. Remote Alarm Contacts: For remote alarm interface.
 - b. Building Control System Interface: Auxiliary contacts in pump controls for interface to building control system and capable of providing the following:
 - c. On-off status of pump.
 - d. Alarm status.
 - e. BCS Interface:
 - 1) For each remote alarm provided at the alarm annunciator panel, provide a set of Form C dry contacts for remote monitoring at the Building Control System provided under Section 23 0900 "Building Control System".
 - 2) In lieu of the dry contacts required in Paragraph A above, the manufacturer shall have the option of furnishing one of the following communications network interfaces to the Building Control System:

2.2 SUMP-PUMP BASINS AND BASIN COVERS

- A. Basins: Factory-fabricated, watertight, cylindrical, basin sump with top flange and sidewall openings for pipe connections.
 - 1. Material: Concrete.
 - 2. Reinforcement: Mounting plates for pumps, fittings, and accessories.

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 121505 Sump Pumps Section 22 1429 - 2
- 3. Anchor Flange: Same material as or compatible with basin sump, cast in or attached to sump, in location and of size required to anchor basin in concrete slab.
- B. Basin Covers: Fabricate metal cover with openings having gaskets, seals, and bushings; for access to pumps, pump shafts, control rods, discharge piping, vent connections, and power cables.
 - 1. Reinforcement: Steel or cast iron, capable of supporting foot traffic for basins installed in foot-traffic areas.

2.3 PACKAGED DRAINAGE-PUMP UNITS

- A. Packaged Pedestal Drainage-Pump Units:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Goulds Pumps; ITT Corporation.
 - b. Liberty Pumps.
 - c. Little Giant Pump Co.
 - d. Zoeller Company.
 - 2. Pump Type: Wet-pit-volute, single-stage, separately-coupled, overhung-impeller centrifugal pump as defined in HI 1.1-1.2 and HI 1.3.
 - 3. Pump Casing: Corrosion-resistant material, with strainer inlet, design that permits flow into impeller, and vertical discharge for piping connection.
 - 4. Impeller: Aluminum, brass, or plastic.
 - 5. Motor: With built-in overload protection and mounted vertically on sump pump column.
 - 6. Power Cord: Three-conductor, waterproof cable of length required but not less than 72 inches, with grounding plug and cable-sealing assembly for connection at pump.
 - 7. Control: Float switch.
- B. Packaged Submersible Drainage-Pump Units:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bell & Gossett Domestic Pump; ITT Corporation.
 - b. Goulds Pumps; ITT Corporation.
 - c. Grundfos Pumps Corp.
 - d. Liberty Pumps.
 - e. Little Giant Pump Co.
 - f. Sta-Rite Industries, Inc.
 - g. Zoeller Company.

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

TLC Engineering Solutions

Project No. 121505 Sump Pumps Section 22 1429 - 3

- 2. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhungimpeller centrifugal pump as defined in HI 1.1-1.2 and HI 1.3.
- 3. Casing: Metal.
- 4. Impeller: Brass.
- 5. Pump Seal: Mechanical.
- 6. Motor: Hermetically sealed, capacitor-start type, with built-in overload protection.
- 7. Power Cord: Three-conductor, waterproof cable of length required but not less than 72 inches (1830 mm), with grounding plug and cable-sealing assembly for connection at pump.
- 8. Pump Discharge Piping: Factory or field fabricated, galvanized, ASTM A 53/A 53M, Schedule 40, steel pipe with ASME B16.4, Class 125, gray iron threaded fittings.
- 9. Control: Motor-mounted float switch.
- 10. Basin: Plastic.

2.4 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 22 Section "Common Motor Requirements for Plumbing Equipment."
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
- B. Motors for submersible pumps shall be hermetically sealed.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for plumbing piping to verify actual locations of storm drainage piping connections before sump pump installation.

3.2 INSTALLATION

- A. Pump Installation Standards: Comply with HI 1.4 for installation of sump pumps.
- B. Provide check valve and isolation valve on discharge of each pump per Division 22 Section "General Duty Valves for Plumbing Piping".

3.3 CONNECTIONS

A. Comply with requirements for piping specified in Division 22 Section "Facility Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties. B. Install piping adjacent to equipment to allow service and maintenance.

3.4 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection.
 - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Pumps and controls will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.5 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.

3.6 ADJUSTING

- A. Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.
- B. Adjust control set points.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps.

END OF SECTION 22 1429

SECTION 22 1513 GENERAL SERVICE COMPRESSED AIR PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes piping and related specialties for general-service compressed-air systems operating at 200 psig or less.

1.3 DEFINITIONS

- A. CR: Chlorosulfonated polyethylene synthetic rubber.
- B. EPDM: Ethylene-propylene-diene terpolymer rubber.
- C. HDPE: High-density polyethylene plastic.
- D. NBR: Acrylonitrile-butadiene rubber.
- E. PE: Polyethylene plastic.
- F. Low-Pressure Compressed-Air Piping: System of compressed-air piping and specialties operating at pressures of 150 psig or less.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Plastic pipes, fittings, and valves.
 - 2. Dielectric fittings.
 - 3. Flexible pipe connectors.
 - 4. Safety valves.
 - 5. Pressure regulators. Include rated capacities and operating characteristics.
 - 6. Automatic drain valves.
 - 7. Filters. Include rated capacities and operating characteristics.
 - 8. Lubricators. Include rated capacities and operating characteristics.
 - 9. Quick couplings.
 - 10. Hose assemblies.
- B. Brazing and welding certificates.
- C. Qualification Data: For Installers.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For general-service compressed-air piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Pressure-Seal Joining Procedure for Copper Tubing: Qualify operators according to training provided by Viega; Plumbing and Heating Systems.
- Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or to AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."
- C. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
- D. ASME Compliance:
 - 1. Comply with ASME B31.9, "Building Services Piping," for low-pressure compressed-air piping.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

- A. Copper Tube: ASTM B 88, Type K or L seamless, drawn-temper, water tube.
 - 1. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, wrought copper with dimensions for brazed joints.
 - 2. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150 or 300.
 - 3. Copper Unions: ASME B16.22 or MSS SP-123.
- B. Transition Couplings for Metal Piping: Metal coupling or other manufactured fitting same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.2 JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for compressed-air piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

2.3 VALVES

A. Metal Ball, Check, Gate, and Globe Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping."

2.4 DIELECTRIC FITTINGS

- A. General Requirements for Dielectric Fittings: Combination fitting of copper alloy and ferrous materials with insulating material; suitable for system fluid, pressure, and temperature. Include threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Dielectric Unions: Factory-fabricated union assembly, for 250-psig minimum working pressure at 180 deg F.
 - a. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. EPCO Sales, Inc.
 - d. Hart Industries International, Inc.
 - e. Watts Water Technologies, Inc.; Water Products Div.
 - f. Zurn Plumbing Products Group; Wilkins Div.
- C. Dielectric Flanges: Factory-fabricated companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
 - a. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. EPCO Sales, Inc.
 - d. Watts Water Technologies, Inc.; Water Products Div.
- D. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
 - 1. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Central Plastics Company.
 - d. Pipeline Seal and Insulator, Inc.

2.5 FLEXIBLE PIPE CONNECTORS

- A. Flexible Pipe Connectors:
 - 1. Flex-Hose Co., Inc.
 - 2. Flexicraft Industries.
 - 3. Hyspan Precision Products, Inc.
 - 4. Mercer Rubber Co.
 - 5. Metraflex, Inc.
 - 6. Proco Products, Inc.
 - 7. Unaflex, Inc.
 - 8. Universal Metal Hose; a Hyspan Company

- B. Bronze-Hose Flexible Pipe Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
 - 1. Working-Pressure Rating: 250 psig minimum.
 - 2. End Connections, NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
 - 3. End Connections, NPS 2-1/2 and Larger: Flanged copper alloy.
- C. Stainless-Steel-Hose Flexible Pipe Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
 - 1. Working-Pressure Rating: 250 psig minimum.
 - 2. End Connections, NPS 2 and Smaller: Threaded steel pipe nipple.
 - 3. End Connections, NPS 2-1/2 and Larger: Flanged steel nipple.

2.6 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with set screws.

2.7 ESCUTCHEONS

- A. General Requirements: Manufactured wall and ceiling escutcheons and floor plates, with ID to closely fit around pipe and tube and OD that completely covers opening.
- B. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Escutcheons: With set screw.
 - 1. Finish: Polished chrome-plated.
- D. One-Piece, Floor-Plate Escutcheons: Cast iron.
- E. Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

2.8 SPECIALTIES

- A. Safety Valves: ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," construction; National Board certified, labeled, and factory sealed; constructed of bronze body with poppet-type safety valve for compressed-air service.
 - 1. Pressure Settings: Higher than discharge pressure and same or lower than receiver pressure rating.
- B. Air-Main Pressure Regulators: Bronze body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 250-psig inlet pressure, unless otherwise indicated.

- 1. Type: Pilot operated.
- C. Air-Line Pressure Regulators: Diaphragm or pilot operated, bronze body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 200-psig minimum inlet pressure, unless otherwise indicated.
- D. Air-Line Pressure Regulators: Diaphragm operated, aluminum alloy or plastic body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 200-psig minimum inlet pressure, unless otherwise indicated.
- E. Automatic Drain Valves: Stainless-steel body and internal parts, rated for 200-psig minimum working pressure, capable of automatic discharge of collected condensate. Include mounting bracket if wall mounting is indicated.
- F. Coalescing Filters: Coalescing type with activated carbon capable of removing water and oil aerosols; with color-change dye to indicate when carbon is saturated and warning light to indicate when selected maximum pressure drop has been exceeded. Include mounting bracket if wall mounting is indicated.
- G. Mechanical Filters: Two-stage, mechanical-separation-type, air-line filters. Equip with deflector plates, resin-impregnated-ribbon-type filters with edge filtration, and drain cock. Include mounting bracket if wall mounting is indicated.
- H. Air-Line Lubricators: With drip chamber and sight dome for observing oil drop entering air stream; with oil-feed adjustment screw and quick-release collar for easy bowl removal. Include mounting bracket if wall mounting is indicated.
 - 1. Provide with automatic feed device for supplying oil to lubricator.

2.9 QUICK COUPLINGS

- A. Manufacturers:
 - 1. Aeroquip Corporation; Eaton Corp.
 - 2. Bowes Manufacturing Inc.
 - 3. Foster Manufacturing, Inc.
 - 4. Milton Industries, Inc.
 - 5. Parker Hannifin Corp.; Fluid Connectors Group; Quick Coupling Div.
 - 6. Schrader-Bridgeport; Amflo Div.
 - 7. Schrader-Bridgeport/Standard Thomson.
 - 8. Snap-Tite, Inc.; Quick Disconnect & Valve Division.
- B. General Requirements for Quick Couplings: Assembly with locking-mechanism feature for quick connection and disconnection of compressed-air hose.
- C. Automatic-Shutoff Quick Couplings: Straight-through brass body with O-ring or gasket seal and stainless-steel or nickel-plated-steel operating parts.
 - 1. Socket End: With one-way valve and threaded inlet for connection to piping or threaded hose fitting.
 - 2. Plug End: Flow-sensor-bleeder, check-valve type with barbed outlet for attaching hose.

- D. Valve-less Quick Couplings: Straight-through brass body with stainless-steel or nickelplated-steel operating parts.
 - 1. Socket End: With O-ring or gasket seal, without valve, and with barbed inlet for attaching hose.
 - 2. Plug End: With barbed outlet for attaching hose.

2.10 HOSE ASSEMBLIES

- A. Description: Compatible hose, clamps, couplings, and splicers suitable for compressedair service, of nominal diameter indicated, and rated for 300-psig minimum working pressure, unless otherwise indicated.
 - 1. Hose: Reinforced single or double wire-braid, CR-covered hose for compressed-air service.
 - 2. Hose Clamps: Stainless-steel clamps or bands.
 - 3. Hose Couplings: Two-piece, straight-through, threaded brass or stainless-steel Oring or gasket-seal swivel coupling with barbed ends for connecting two sections of hose.
 - 4. Hose Splicers: One-piece, straight-through brass or stainless-steel fitting with barbed ends for connecting two sections of hose.

2.11 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Compressed-Air Piping between Air Compressors and Receivers: Use one of the following piping materials for each size range:
 - 1. NPS 2 and Smaller: Type K or L, copper tube; wrought-copper fittings; and brazed joints.
 - 2. NPS 2-1/2 to NPS 4: Type K or L, copper tube; wrought-copper fittings; and brazed joints.
- B. Low-Pressure Compressed-Air Distribution Piping: Use one of the following piping materials for each size range:
 - 1. NPS 2 and Smaller: Type K or L, copper tube; wrought-copper fittings; and brazed or soldered joints.
- C. Drain Piping: Use the following piping materials:

1. NPS 2 and Smaller: Type M copper tube; wrought-copper fittings; and brazed or soldered joints.

3.2 VALVE APPLICATIONS

- A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for metal general-duty valves. Use metal valves, unless otherwise indicated.
 - 1. Metal General-Duty Valves: Use valve types specified in "Valve Applications" Article in Division 22 Section "General-Duty Valves for Plumbing Piping" according to the following:
 - a. Low-Pressure Compressed Air: Valve types specified for low-pressure compressed air.
 - b. Equipment Isolation NPS 2 and Smaller: Safety-exhaust, copper-alloy ball valve with exhaust vent and pressure rating at least as great as piping system operating pressure.

3.3 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of compressed-air piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install piping concealed from view and protected from physical contact by building occupants, unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited, unless otherwise indicated.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and to coordinate with other services occupying that space.
- E. Install piping adjacent to equipment and machines to allow service and maintenance.
- F. Install air and drain piping with 1 percent slope downward in direction of flow.
- G. Install nipples, flanges, unions, transition and special fittings, and valves with pressure ratings same as or higher than system pressure rating, unless otherwise indicated.
- H. Equipment and Specialty Flanged Connections:
 - 1. Use steel companion flange with gasket for connection to steel pipe.
 - 2. Use cast-copper-alloy companion flange with gasket and brazed or soldered joint for connection to copper tube. Do not use soldered joints for connection to air compressors or to equipment or machines producing shock or vibration.

- I. Install eccentric reducers where compressed-air piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.
- J. Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.
- K. Install thermometer and pressure gage on discharge piping from each air compressor and on each receiver. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping."
- L. Install piping to permit valve servicing.
- M. Install piping free of sags and bends.
- N. Install fittings for changes in direction and branch connections.

3.4 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Brazed Joints for Copper Tubing: Join according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Join according to ASTM B 828 or CDA's "Copper Tube Handbook."
- E. Flanged Joints: Use asbestos-free, nonmetallic gasket suitable for compressed air. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.
- F. Dissimilar Metal Piping Material Joints: Use dielectric fittings.

3.5 VALVE INSTALLATION

- A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing
- B. Install shutoff valves and unions or flanged joints at compressed-air piping to air compressors.
- C. Install shutoff valve at inlet to each automatic drain valve, filter, lubricator, and pressure regulator.
- D. Install check valves to maintain correct direction of compressed-air flow to and from compressed-air piping specialties and equipment.

3.6 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. NPS 2 and Smaller: Use dielectric unions.

C. NPS 2-1/2 to NPS 4: Use dielectric flanges.

3.7 FLEXIBLE PIPE CONNECTOR INSTALLATION

- A. Install flexible pipe connectors in discharge piping and in inlet air piping from remote airinlet filter of each air compressor.
- B. Install bronze-hose flexible pipe connectors in copper compressed-air tubing.
- C. Install stainless-steel-hose flexible pipe connectors in steel compressed-air piping.

3.8 SPECIALTY INSTALLATION

- A. Install safety valves on receivers in quantity and size to relieve at least the capacity of connected air compressors.
- B. Install air-main pressure regulators in compressed-air piping at or near air compressors.
- C. Install air-line pressure regulators in branch piping to equipment.
- D. Install automatic drain valves on aftercoolers, receivers, and dryers. Discharge condensate onto nearest floor drain.
- E. Install coalescing filters in compressed-air piping at or near air compressors and upstream from mechanical filters. Mount on wall at locations indicated.
- F. Install mechanical filters in compressed-air piping at or near air compressors and downstream from coalescing filters. Mount on wall at locations indicated.
- G. Install air-line lubricators in branch piping to machine tools. Mount on wall at locations indicated.
- H. Install quick couplings at piping terminals for hose connections.
- I. Install hose assemblies at hose connections.

3.9 CONNECTIONS

- A. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment and machine.
- B. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment and machine.

3.10 SLEEVE INSTALLATION

- A. Sleeves are not required for core-drilled holes.
- B. Permanent sleeves are not required for holes formed by removable PE sleeves.
- C. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs using stack sleeve fittings.

- D. Install sleeves for pipes passing through concrete and masonry walls, gypsum board partitions, and concrete floor and roof slabs.
 - 1. Wall Penetrations: Cut sleeves to length for mounting flush with both surfaces.
 - 2. Floor Penetrations: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
- E. Install sleeves in new walls and slabs as new walls and slabs are constructed.
- F. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - 1. Steel Pipe Sleeves: For pipes smaller than NPS 6.
 - 2. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum board partitions.
 - 3. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Comply with requirements in Division 07 Section "Sheet Metal Flashing and Trim" for flashing.

a. Seal space outside of sleeve fittings with grout.

G. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.11 ESCUTCHEON INSTALLATION

- A. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
 - b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
 - c. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
 - d. Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish.
 - e. Bare Piping in Equipment Rooms: One piece, cast brass.
 - f. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

3.12 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.
- B. Vertical Piping: MSS Type 8 or 42, clamps.
- C. Individual, Straight, Horizontal Piping Runs:
 - 1. 100 Feet or Less: MSS Type 1, adjustable, steel clevis hangers.
 - 2. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
- D. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
- E. Base of Vertical Piping: MSS Type 52, spring hangers.
- F. Support horizontal piping within 12 inches of each fitting and coupling.
- G. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- H. Install hangers for Schedule 40, steel piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1/4 to NPS 1/2: 96 inches with 3/8-inch rod.
 - 2. NPS 3/4 to NPS 1-1/4: 84 inches with 3/8-inch rod.
 - 3. NPS 1-1/2: 12 feet with 3/8-inch rod.
 - 4. NPS 2: 13 feet with 3/8-inch rod.
 - 5. NPS 2-1/2: 14 feet with 1/2-inch rod.
 - 6. NPS 3: 15 feet with 1/2-inch rod.
 - 7. NPS 3-1/2: 16 feet with 1/2-inch rod.
 - 8. NPS 4: 17 feet with 5/8-inch rod.
- I. Install supports for vertical, Schedule 40, steel piping every 15 feet.
- J. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1/4: 60 inches with 3/8-inch rod.
 - 2. NPS 3/8 and NPS 1/2: 72 inches with 3/8-inch rod.
 - 3. NPS 3/4: 84 inches with 3/8-inch rod.
 - 4. NPS 1: 96 inches with 3/8-inch rod.
 - 5. NPS 1-1/4: 108 inches with 3/8-inch rod.
 - 6. NPS 1-1/2: 10 feet with 3/8-inch rod.
 - 7. NPS 2: 11 feet with 3/8-inch rod.
 - 8. NPS 2-1/2: 13 feet with 1/2-inch rod.
 - 9. NPS 3: 14 feet with 1/2-inch rod.
 - 10. NPS 3-1/2: 15 feet with 1/2-inch rod.
 - 11. NPS 4: 16 feet with 1/2-inch rod.
- K. Install supports for vertical copper tubing every 10 feet.

3.13 LABELING AND IDENTIFICATION

A. Install identifying labels and devices for general-service compressed-air piping, valves, and specialties. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.14 FIELD QUALITY CONTROL

- A. Perform field tests and inspections.
- B. Tests and Inspections:
 - 1. Piping Leak Tests for Metal Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen to pressure of 50 psig above system operating pressure, but not less than 150 psig. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
 - 2. Repair leaks and retest until no leaks exist.
 - 3. Inspect filters, lubricators and pressure regulators for proper operation.
- C. Prepare test reports.

END OF SECTION 22 1513

SECTION 22 1519 GENERALSERVICE PACKAGED AIR COMPRESSORS AND RECEIVERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Oil-free, reciprocating air compressors.
 - 2. Inlet-air filters.
 - 3. Air-cooled, compressed-air aftercoolers.
 - 4. Refrigerant compressed-air dryers.
 - 5. Desiccant compressed-air dryers.
 - 6. Computer interface cabinet.

1.3 DEFINITIONS

- A. Actual Air: Air delivered from air compressors. Flow rate is delivered compressed air measured in a cfm.
- B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- C. Standard Air: Free air at 68 deg F and 1 atmosphere (29.92 in. Hg) before compression or expansion and measured in scfm.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 1. Wiring Diagrams: For power, signal, and control wiring.
- B. Operation and Maintenance Data: For compressed-air equipment to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASME Compliance: Fabricate and label receivers to comply with ASME Boiler and Pressure Vessel Code.

1.6 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

JFL - THS 5 ACRE LAND LEASE SITE		Project No. 121505
Procurement Package	General-Service Packaged	Air Compressors & Receivers
07/21/2023	TLC Engineering Solutions	Section 22 1519 - 1

1.7 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Air-Compressor, Inlet-Air-Filter Elements: Equal to percent of amount installed, but no fewer than two (2) units.
 - 2. Belts: Two for each belt-driven compressor.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PACKAGED AIR COMPRESSORS AND RECEIVERS

- A. General Description: Factory-assembled, -wired, -piped, and -tested; electric-motordriven; air-cooled; continuous-duty air compressors and receivers that deliver air of quality equal to intake air.
- B. Control Panels: Automatic control station with load control and protection functions. Comply with NEMA ICS 2 and UL 508.
 - 1. Enclosure: NEMA ICS 6, Type 12 control panel unless otherwise indicated.
 - 2. Motor Controllers: Full-voltage, combination magnetic type with undervoltage release feature and motor-circuit-protector-type disconnecting means and short-circuit protective device.
 - 3. Control Voltage: 120-V ac or less, using integral control power transformer.
 - 4. Motor Overload Protection: Overload relay in each phase.
 - 5. Starting Devices: Hand-off-automatic selector switch in cover of control panel, plus pilot device for automatic control.
 - 6. Automatic control switches to sequence lead-lag compressors for multiplex air compressors.
 - 7. Instrumentation: Include discharge-air pressure gage, air-filter maintenance indicator, hour meter, compressor discharge-air and coolant temperature gages, and control transformer.
 - 8. Alarm Signal Device: For connection to alarm system to indicate when backup air compressor is operating.
 - 9. Short Circuit Rating: Entire control panel assembly shall have a short circuit current rating of no less than 65,000 amperes symmetrical at 480V.
- C. Receivers: Steel tank constructed according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
 - 1. Pressure Rating: At least as high as highest discharge pressure of connected compressors, and bearing appropriate code symbols.
 - 2. Interior Finish: Corrosion-resistant coating.
 - 3. Accessories: Include safety valve, pressure gage, drain, and pressure-reducing valve.

2.2 OIL-FREE, RECIPROCATING AIR COMPRESSORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. EMSE
 - 2. Ingersoll-Rand; Air Solutions Group.
 - 3. Quincy Compressor; an EnPro Industries company.
- B. Compressor(s): Oil-free, reciprocating-piston type with nonlubricated compression chamber, lubricated crankcase, and of construction that prohibits oil from entering compression chamber.
 - 1. Submerged gear-type oil pump.
 - 2. Oil filter.
 - 3. Combined high discharge-air temperature and low lubrication-oil pressure switch.
 - 4. Belt guard totally enclosing pulleys and belts.

2.3 INLET-AIR FILTERS

- A. Description: Combination inlet-air filter-silencer, suitable for remote installation, for each air compressor.
 - 1. Construction: Weatherproof housing for replaceable, dry-type filter element, with silencer tubes or other method of sound reduction.
 - 2. Capacity: Match capacity of air compressor, with filter having collection efficiency of 99 percent retention of particles larger than 10 micrometers.
- B. Description: Combination inlet-air filter-silencer, suitable for remote installation, for multiple air compressors.
 - 1. Construction: Weatherproof housing for replaceable, dry-type filter element, with silencer tubes or other method of sound reduction.
 - 2. Capacity: Match total capacity of connected air compressors, with filter having collection efficiency of 99 percent retention of particles larger than 10 micrometers.

2.4 AIR-COOLED, COMPRESSED-AIR AFTERCOOLERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 - 1. Hankison International.
 - 2. Ingersoll-Rand; Air Solutions Group.
 - 3. Zeks Compressed Air Solutions.
- B. Description: Electric-motor-driven, fan-operation, finned-tube unit; rated at 250 psig and leak tested at 350-psig minimum air pressure; in capacities indicated. Size units to cool compressed air in compressor-rated capacities to 10 deg F above summertime maximum ambient temperature. Include moisture separator and automatic drain.

2.5 REFRIGERANT COMPRESSED-AIR DRYERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 - 1. Hankison International.
 - 2. Ingersoll-Rand; Air Solutions Group.
 - 3. Zeks Compressed Air Solutions.
- B. Description: Noncycling, air-cooled, electric-motor-driven unit with steel enclosure and capability to deliver 35 deg F, 100-psig air at dew point. Include automatic ejection of condensate from airstream, step-down transformers, disconnect switches, inlet and outlet pressure gages, thermometers, automatic controls, and filters.

2.6 DESICCANT COMPRESSED-AIR DRYERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 - 1. Hankison International.
 - 2. Ingersoll-Rand; Air Solutions Group.
 - 3. Zeks Compressed Air Solutions.
- B. Description: Twin-tower unit with purge system, mufflers, and capability to deliver plus 10 deg F, 100-psig air at dew point. Include dew point controlled purge, step-down transformers, disconnect switches, inlet and outlet pressure gages, thermometers, automatic controls, and filters.

2.7 BUILDING CONTROL SYSTEM INTERFACE CABINET

- A. Description:
 - 1. Wall mounting.
 - 2. Welded steel with white enamel finish.
 - 3. Gasketed door.
 - 4. Grounding device.
 - 5. Factory-installed, signal circuit boards.
 - 6. Power transformer.
 - 7. Circuit breaker.
 - 8. Wiring terminal board.
 - 9. Internal wiring capable of interfacing 20 alarm signals.

2.8 BUILDING CONTROL SYSTEM INTERFACE

- A. For each remote alarm provided at the Building Control System interface panel, provide a set of Form C dry contacts for remote monitoring at the Building Control System provided under Section 23 0900 "Building Control System".
- B. In lieu of the dry contacts required in Paragraph A above, the manufacturer shall have the option of furnishing one of the following communications network interfaces to the Building Control System:

- C. An industry standard open protocol communications network interface fully compatible with and interconnecting with the Building Control System communications network, based on one of the following network communications protocols:
- D. BACNet TCP/IP– network communications shall use ASHRAE 135 protocol and communicate using ISO 802-3 (Ethernet) datalink/physical layer protocol;
- E. BACNet MS/TP network communications shall use ASHRAE 135 read (execute and initiate) and write (execute and initiate) property services defined in ASHRAE 135, residing on network using MS/TP datalink/physical layer protocol and have service communication port for connection to the BCS; or,
- F. ModBus/TP network communications shall use ModBus/TP over TCP/IP network.
- G. Communications network hardware and firmware to allow communications with an IP address communicating directly over the Facility local area network complying with ISO 802-3 (Ethernet).

2.9 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 22 Section "Common Motor Requirements for Plumbing Equipment."
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

- A. Equipment Mounting: Install air compressors aftercoolers, and dryers on concrete bases using.
 - 1. Minimum Deflection: 1/4 inch.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 - 3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
- B. Equipment Mounting: Install desiccant compressed-air dryers on concrete bases. Comply with requirements inDivision 03 Section "Miscellaneous Cast-in-Place Concrete."

- 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
- 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
- 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
- 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
- C. Install compressed-air equipment anchored to substrate.
- D. Arrange equipment so controls and devices are accessible for servicing.
- E. Maintain manufacturer's recommended clearances for service and maintenance.
- F. Install the following devices on compressed-air equipment:
 - 1. Thermometer, Pressure Gage, and Safety Valve: Install on each compressed-air receiver.
 - 2. Automatic Drain Valves: Install on aftercoolers, receivers, and dryers. Discharge condensate over nearest floor drain.

3.2 CONNECTIONS

- A. Comply with requirements for piping specified in Division 22 Section "General-Service Compressed-Air Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.

3.3 IDENTIFICATION

A. Identify general-service air compressors and components. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.4 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Check for lubricating oil in lubricated-type equipment.
 - 3. Check belt drives for proper tension.
 - 4. Verify that air-compressor inlet filters and piping are clear.

- 5. Check for equipment vibration-control supports and flexible pipe connectors and verify that equipment is properly attached to substrate.
- 6. Check safety valves for correct settings. Ensure that settings are higher than aircompressor discharge pressure but not higher than rating of system components.
- 7. Drain receiver tanks.
- 8. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
- 9. Test and adjust controls and safeties.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air compressors, aftercoolers, and air dryers.

END OF SECTION 22 1519

SECTION 22 3100 DOMESTIC WATER SOFTENERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes commercial water softeners.
 - 1. Chemicals.
 - 2. Water testing kits.

1.3 **DEFINITIONS**

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. FRP: Fiberglass-reinforced plastic.
- C. PE: Polyethylene plastic.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Water Softeners. Include rated capacities, operating characteristics, furnished specialties, and accessories.
 - 2. Water testing kits.
- B. Shop Drawings: For water softeners. Include plans, elevations, sections, details, and connections to piping systems.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Manufacturer Certificates: Signed by manufacturers certifying that water softeners comply with requirements.
- D. Source quality-control test reports.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For water softeners to include in emergency, operation, and maintenance manuals.
- G. Warranty: Special warranty specified in this Section.
- H. Maintenance service agreement.

1.5 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of water softeners and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. ASME Compliance Code: Fabricate and label mineral tanks to comply with ASME Boiler and Pressure Vessel Code.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of water softener that fails in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures of mineral and brine tanks.
 - b. Faulty operation of controls.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
 - d. Attrition loss of resin exceeding 3 percent per year.
 - e. Mineral washed out of system during service run or backwashing period.
 - f. Effluent turbidity greater and color darker than incoming water.
 - g. Fouling of underdrain system, gravel, and resin, with turbidity or by dirt, rust, or scale from softener equipment or soft water, while operating according to manufacturer's written operating instructions.
 - 2. Commercial Water Softener, Warranty Period: From date of Substantial Completion.
 - a. Mineral Tanks: Five years.
 - b. Brine Tanks: Three years.
 - c. Controls: Five years.

1.8 MAINTENANCE SERVICE

A. Maintenance: Submit four copies of manufacturer's "Agreement for Continued Service and Maintenance," before Substantial Completion, for Owner's acceptance. Offer terms and conditions for furnishing chemicals and providing continued testing and servicing to include replacing materials and equipment. Include one-year term of agreement with option for one-year renewal.

1.9 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- 1. Salt for Brine Tanks: Furnish same form as and at least three times original load, but not less than 200 lb. Deliver on pallets.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
- 1. Manufacturers: Subject to compliance with requirements, provide by one of the following.

2.2 COMMERCIAL WATER SOFTENERS

- A. Description: Central Supply Factory-assembled, pressure-type water softener. System that consists of two softener tanks, one brine tank, interconnecting piping, valves and controller.
- 1. Manufacturers:
 - a. Marlo Incorporated
 - b. Siemens Water Technology
- 2. Comply with NSF 61, "Drinking Water System Components--Health Effects."
- 3. Configuration: Twin unit with two mineral tanks and one brine tank, factory mounted on skids.
- 4. Mineral Tanks: Welded steel, pressure-vessel quality.
 - a. Construction: Fabricated and stamped to comply with ASME Boiler and Pressure Vessel Code.
 - b. Pressure Rating: 125 psig minimum.
 - c. Sick Shells: Shall be adequate to allow for bed expansion during backwash.
 - d. Tanks shall have a minimum of 12" x 16" access opening. Tanks shall be sandblasted and painted with epoxy material.
 - e. Support Legs: Four Legs constructed of structural steel, welded to tank before testing and labeling.
 - f. Interconnecting Pipe between Vessels: Single, point type, fabricated from Schedule 10 316L stainless-steel pipe and fittings.
 - g. Internals: Schedule 80 PVC type with a single point distributor, upper distributor and hub lateral lower distribution.

- h. Liner: Epoxy material suitable for potable water.
- 5. Controls: Fully automatic; factory mounted on unit and factory wired.
 - a. Softeners shall operate in two Modes: Service and regeneration.

Duplex parallel operation consists of two vessels that will both run in Service Mode. Upon request of a regeneration cycle, both units will regenerate consecutively (Unit A, then Unit B) leaving one unit on line at all times. A totalizing meter shall initiate regeneration. An operator can manually initiate the regeneration process at anytime.

- b. The softener controls are housed in a single carbon steel NEMA 4 control panel mounted on the skid. All skid wiring (for instrumentation, etc.) and pneumatic tubing (for automated valves) originate from the control panel. This single control panel will provide control and monitoring. The control panel is provided with a Programmable Logic Controller (PLC) and operator interface. An S7-200 Siemens PLC is utilized to provide reliable control of the system's operating and safety functions. A 6" Touch Screen, Human Machine Interface (HMI), acts as the interface between the operator and the process. An Ethernet module is provided for communication with a SCADA or other control system.
- 6. Brine Tank: Combination measuring and wet-salt storing system.
 - a. This system in High Density PE, 3/8 inch thick included with an educator, a level controlled brine draw, and a refill valve. The brine tank is designed as a wet system. The salt level in the tank is always below the air check on the brine valve.
 - b. Size: Large enough for at least three regenerations at full salting.
- 7. Factory-Installed Accessories:
 - a. Piping, valves, tubing, and drains.
 - b. Sampling cocks.
 - c. Main-operating-valve position indicators.
 - d. Water meters.

2.3 CHEMICALS

- A. Mineral: High-capacity, sulfonated-polystyrene ion-exchange resin that is stable over entire pH range with good resistance to bead fracture from attrition or shock. The exchange resin shall be supported by a gravel bed.
 - 1. Exchange Capacity: 30,000 grains/cu. ft. of calcium carbonate of resin when regenerated with 15 lb of salt. The exchange resin shall be supported by a gravel bed.
- B. Salt for Brine Tanks: High-purity sodium chloride, free of dirt and foreign material. Rock and granulated forms are not acceptable.

2.4 WATER TESTING SETS

A. Description: Manufacturer's standard water-hardness testing apparatus and chemicals with testing procedure instructions. Include metal container suitable for wall mounting.

2.5 SOURCE QUALITY CONTROL

- A. Hydrostatically test mineral tanks before shipment to minimum of one and one-half times pressure rating.
- B. Prepare test reports.

PART 3 - EXECUTION

3.1 CONCRETE BASES

- A. Install concrete bases of dimensions indicated for commercial water softeners. Refer to Division 22 Section "Common Work Results for Plumbing."
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
 - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevation required for proper attachment to supported equipment.
- B. Cast-in-place concrete materials and placement requirements are specified in Division 03.

3.2 WATER SOFTENER INSTALLATION

- A. Install commercial water softener equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor mineral and brine tanks and floormounting accessories to substrate.
- B. Install brine lines and fittings furnished by equipment manufacturer but not specified to be factory installed.
- C. Prepare mineral-tank distribution system and underbed for minerals and place specified mineral into mineral tanks.
- D. Install water testing sets mounted on wall, unless otherwise indicated, and near water softeners.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.

- C. Make piping connections between water-softener-unit headers and dissimilar-metal water piping with dielectric fittings. Dielectric fittings are specified in Division 22 Section "Common Work Results for Plumbing."
- D. Install shutoff valves on raw-water inlet and soft-water outlet piping of each mineral tank, and on inlet and outlet headers.
 - 1. Metal general-duty valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
 - 2. Plastic valves are specified in Division 22 Section "Domestic Water Piping."
 - 3. Exception: Water softeners with factory-installed shutoff valves at locations indicated.
- E. Install pressure gages on raw-water inlet and soft-water outlet piping of each mineral tank. Pressure gages are specified in Division 22 Section "Meters and Gages for Plumbing Piping."
 - 1. Exception: Water softeners with factory-installed pressure gages at locations indicated.
 - 2. Exception: Water softeners in hot-water service.
- F. Install valved bypass water piping around water softeners.
 - 1. Metal general-duty valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
 - 2. Water piping is specified in Division 22 Section "Domestic Water Piping."
- G. Install drains as indirect wastes to spill into open drains or over floor drains.
- H. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- I. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning water softeners that do not pass tests and inspections and retest as specified above.

3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
- B. Add water to brine tanks and fill with salt.
- C. Sample water softener effluent after startup and at three consecutive seven-day intervals (total of four samples), and prepare certified test reports for required water performance characteristics. Comply with the following:
 - 1. ASTM D 859, "Test Method for Silica in Water."
 - 2. ASTM D 1067, "Test Methods for Acidity or Alkalinity of Water."
 - 3. ASTM D 1068, "Test Methods for Iron in Water."
 - 4. ASTM D 1126, "Test Method for Hardness in Water."
 - 5. ASTM D 1129, "Terminology Relating to Water."
 - 6. ASTM D 3370, "Practices for Sampling Water from Closed Conduits."

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water softeners. Refer to Division 01 "Demonstration and Training" Section.

END OF SECTION 22 3100

SECTION 22 4000 PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following conventional plumbing fixtures and related components:
 - 1. Faucets for lavatories, bathtubs, bathtub/showers, showers and sinks.
 - 2. Laminar-flow faucet-spout outlets.
 - 3. Flush Valves.
 - 4. Toilet seats.
 - 5. Protective shielding guards.
 - 6. Fixture supports.
 - 7. Dishwasher air-gap fittings.
 - 8. Water closets.
 - 9. Urinals.
 - 10. Lavatories.
 - 11. Bathtubs.
 - 12. Individual showers.
 - 13. Sinks.
 - 14. Service basins.

1.3 SUBMITTALS

- A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.
- B. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation, and maintenance manuals.
- C. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.
 - 1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

- C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.
- D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
- E. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- F. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
- G. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
 - 1. Plastic Mop-Service Basins: ANSI Z124.6.
 - 2. Slip-Resistant Bathing Surfaces: ASTM F 462.
 - 3. Solid-Surface-Material Lavatories and Sinks: ANSI/ICPA SS-1.
 - 4. Stainless-Steel Sinks: ASME A112.19.3.
 - 5. Vitreous-China Fixtures: ASME A112.19.2M.
 - 6. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.
- H. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:
 - 1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
 - 2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
 - 3. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
 - 4. Faucets: ASME A112.18.1.
 - 5. Hose-Connection Vacuum Breakers: ASSE 1011.
 - 6. Hose-Coupling Threads: ASME B1.20.7.
 - 7. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
 - 8. NSF Potable-Water Materials: NSF 61.
 - 9. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
- I. Comply with the following applicable standards and other requirements specified for bathtub bathtub/shower and shower faucets:
 - 1. Backflow Protection Devices for Hand-Held Showers: ASME A112.18.3M.
 - 2. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.
 - 3. Deck-Mounted Bath/Shower Transfer Valves: ASME 18.7.
 - 4. Faucets: ASME A112.18.1.
 - 5. Hand-Held Showers: ASSE 1014.
 - 6. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445.
 - 7. Pressure-Equalizing-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
 - 8. Thermostatic-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
- J. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
 - 1. Atmospheric Vacuum Breakers: ASSE 1001.
 - 2. Dishwasher Air-Gap Fittings: ASSE 1021.
 - 3. Manual-Operation Flushometers: ASSE 1037.
 - 4. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

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- K. Comply with the following applicable standards and other requirements specified for miscellaneous components:
 - 1. Dishwasher Air-Gap Fittings: ASSE 1021.
 - 2. Off-Floor Fixture Supports: ASME A112.6.1M.
 - 3. Plastic Toilet Seats: ANSI Z124.5.

1.5 WARRANTY

- A. Special Warranties: Manufacturer's standard form in which manufacturer agrees to repair or replace components of whirlpools that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures of unit shell.
 - b. Faulty operation of controls, blowers, pumps, heaters, and timers.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
 - 2. Warranty Period for Commercial Applications: One year from date of Substantial Completion.
 - 3. Warranty Period for Residential Applications of Electronic Controls: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LAVATORY FAUCETS

- A. Lavatory Faucets:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Chicago Faucets
 - b. T & S Brass and Bronze Works, Inc.

2.2 SHOWER FAUCETS

- A. Shower Faucets:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Powers; a Watts Industries Co.
 - b. Symmons Industries, Inc.

2.3 SINK FAUCETS

- A. Sink Faucets:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Chicago Faucets.
 - b. T & S Brass and Bronze Works, Inc.

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2.4 LAMINAR-FLOW FAUCET-SPOUT OUTLETS

- A. Laminar-Flow Faucet-Spout Outlets:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Chronomite Laboratories, Inc.
 - b. NEOPERL, Inc.
 - 2. Description: Chrome-plated-brass faucet-spout outlet that produces non-aerating, laminar stream. Include male or female thread that mates with faucet outlet for attachment to faucets where indicated and flow-rate range that includes flow of faucet.

2.5 FLUSH VALVES

- A. Flush Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Sloan Valve Company.
 - b. Zurn Plumbing Products Group; Commercial Brass Operation.

2.6 TOILET SEATS

- A. Toilet Seats:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bemis Manufacturing Company.
 - b. Centoco Manufacturing Corp.
 - c. Olsonite Corp.

2.7 FIXTURE SUPPORTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Josam Company.
 - 2. MIFAB Manufacturing Inc.
 - 3. Smith, Jay R. Mfg. Co.
 - 4. Tyler Pipe; Wade Div.
 - 5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
 - 6. Zurn Plumbing Products Group; Specification Drainage Operation.

2.8 DISHWASHER AIR-GAP FITTINGS

- A. Dishwasher Air-Gap Fittings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brass Craft Mfg. Co.; a Subsidiary of Masco Corporation.

- b. Sioux Chief Manufacturing Company, Inc.
- c. Watts Brass & Tubular; a division of Watts Regulator Co.

2.9 WATER CLOSETS

- A. Water Closets:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard Companies, Inc.
 - b. Kohler Co.

2.10 URINALS

- A. Urinals:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard Companies, Inc.
 - b. Kohler Co.

2.11 LAVATORIES

- A. Lavatories:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard Companies, Inc.
 - b. Kohler Co.

2.12 SINKS

- A. Sinks:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the into tthe following:
 - a. Elkay Manufacturing Co.
 - b. Just Manufacturing Company.
 - c. Grifford

2.13 SERVICE BASINS

- A. Service Basins:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the the following:
 - a. Acorn Engineering Company.
 - b. Crane Plumbing, L.L.C./Fiat Products.
 - c. Stern-Williams Co., Inc.

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PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.
- B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.
- B. Install floor-mounted carriers for wall-mounted fixtures.
 - 1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
 - 2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
 - 3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.
- C. Install back-outlet, wall-mounted fixtures onto waste fitting seals and attach to supports.
- D. Install floor-mounted fixtures on closet flanges or other attachments to piping or building substrate.
- E. Install wall-mounted fixtures with tubular waste piping attached to supports.
- F. Install floor-mounted, back-outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.
- G. Install counter-mounted fixtures in and attached to casework.
- H. Install fixtures level and plumb according to roughing-in drawings.
- I. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
 - 1. Exception: Use ball valves if supply stops are not specified with fixture. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
- J. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
- K. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.
- L. Install flush valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

- M. Install toilet seats on water closets.
- N. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- O. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.
- P. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- Q. Install shower flow-control fittings with specified maximum flow rates in shower arms.
- R. Install traps on fixture outlets.
 - 1. Exception: Omit trap on fixtures with integral traps.
 - 2. Exception: Omit trap on indirect wastes, unless otherwise indicated.
- S. Install dishwasher air-gap fitting at each sink indicated to have air-gap fitting. Install in sink deck. Connect inlet hose to dishwasher and outlet hose to disposer.
- T. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."
- U. Set shower receptors and service basins in leveling bed of cement grout. Grout is specified in Division 22 Section "Common Work Results for Plumbing."
- V. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.
- B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.
- C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.
- D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.
- E. Install fresh batteries in sensor-operated mechanisms.

3.5 ADJUSTING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
- B. Operate and adjust disposers, hot-water dispensers and controls. Replace damaged and malfunctioning units and controls.
- C. Adjust water pressure at faucets and flush valves to produce proper flow and stream.
- D. Replace washers and seals of leaking and dripping faucets and stops.
- E. Install fresh batteries in sensor-operated mechanisms.

3.6 CLEANING

- A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:
 - 1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
 - 2. Remove sediment and debris from drains.
- B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.7 **PROTECTION**

- A. Provide protective covering for installed fixtures and fittings.
- B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 4000

SECTION 22 4300 HEALTHCARE PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following medical plumbing fixtures and related components:
 - 1. Fixture supports.
 - 2. Clinical sinks.
 - 3. Plaster sinks.
 - 4. Surgeons' scrub sinks.
 - 5. Outlet boxes.

1.3 **DEFINITIONS**

- A. Accessible Medical Plumbing Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.
- B. Fitting: Device that controls the flow of water into or out of the medical plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads, drains and tailpieces, and traps and waste pipes.
- C. FRP: Fiberglass-reinforced plastic.
- D. PMMA: Polymethyl methacrylate (acrylic) plastic.

1.4 SUBMITTALS

- A. Product Data: For each type of medical plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Operation and Maintenance Data: For medical plumbing fixtures to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain medical plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.
 - 1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities "Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.
- D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
- E. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- F. Select combinations fixtures and trim, faucets, fittings, and other components that are compatible.
- G. Comply with the following applicable standards and other requirements specified for medical plumbing fixtures:
 - 1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
 - 2. Plastic Shower Enclosures: ANSI Z124.2.
 - 3. Slip-Resistant Bathing Surfaces: ASTM F 462.
 - 4. Vitreous-China Fixtures: ASME A112.19.2M.

PART 2 - PRODUCTS

2.1 BEDPAN WASHERS

- A. Bedpan Washers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Chicago Faucets.
 - b. T & S Brass and Bronze Works, Inc.
 - c. Zurn Plumbing Products Group; Commercial Brass Operation.

2.2 CLINICAL SINKS

- A. Wall-Mounting Clinical Sinks:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard Companies, Inc.
 - b. Eljer.
 - c. Kohler Co.

2.3 SURGEONS' SCRUB SINKS

A. Stainless-Steel Surgeons' Scrub Sinks:

- 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Whitehall Manufacturing; a division of Acorn Engineering Company.
- 2. Description: Wall-mounting, sink-type medical plumbing fixture.
- B. Vitreous-China Surgeons' Scrub Sinks:
 - 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, the following:
 - a. American Standard Companies, Inc.
 - b. Crane Plumbing, L.L.C./Fiat Products.
 - c. Kohler Co.
 - 2. Description: Wall-mounting, sink-type medical plumbing fixture.

2.4 SURGEONS' INSTRUMENT SINKS

- A. Surgeons' Instrument Sinks:
 - 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, the following:

a.Elkay Manufacturing Co. b.Just Manufacturing Company.

2. Description: Wall-mounting, stainless-steel, sink-type medical plumbing fixture. Include instrument tray on each side.

2.5 OUTLET BOXES

- A. Dialysis Equipment Outlet Boxes:
 - 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Acorn Engineering Company.
 - b. Bradley Corporation.
 - c. Willoughby
 - d. Whitehall Manufacturing; a division of Acorn Manufacturing Company.
 - 2. Description: Recessed-mounting outlet box with water supply and drain connections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for medical plumbing fixtures to verify actual locations of piping connections before fixture installation.

- B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Assemble medical plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.
- B. Install floor mounted carriers for wall-mounting fixtures.
 - 1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
 - 2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
 - 3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.
- C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.
- D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.
- E. Install wall-mounting fixtures with tubular waste piping attached to supports.
- F. Install counter-mounting fixtures in and attached to casework.
- G. Install fixtures level and plumb according to roughing-in drawings.
- H. Install water-supply piping with stop on each supply to each fixture to be connected to domestic water piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
 - 1. Exception: Use ball, gate, or globe valve if stops are not specified with fixture. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
- I. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
- J. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- K. Install traps on fixture outlets.
 - 1. Exception: Omit trap on fixtures with integral traps.
- L. Install escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."
- M. Seal joints between fixtures and walls, floors, and counters using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect water supplies from domestic water piping to medical plumbing fixtures.
- C. Connect drain piping from medical plumbing fixtures to sanitary waste and vent piping.
- D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Verify that installed medical plumbing fixtures are categories and types specified for locations where installed.
- B. Check that medical plumbing fixtures are complete with trim, faucets, fittings, and other specified components.
- C. Inspect installed medical plumbing fixtures for damage. Replace damaged fixtures and components.
- D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.
- E. Install fresh batteries in sensor-operated mechanisms.

3.5 ADJUSTING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning medical plumbing fixtures, fittings, and controls.
- B. Replace washers and seals of leaking and dripping faucets and stops.

3.6 CLEANING

- A. Clean medical plumbing fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:
 - 1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
 - 2. Remove sediment and debris from drains.
- B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.7 **PROTECTION**

- A. Provide protective covering for installed fixtures and fittings.
- B. Do not allow use of medical plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF DOCUMENT 22 4300

SECTION 22 4500 EMERGENCY PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following emergency plumbing fixtures:
 - 1. Emergency showers.

1.3 DEFINITIONS

- A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.
- B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.
- C. Self-Contained Emergency Plumbing Fixture: Fixture with flushing-fluid-solution supply.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include flow rates and capacities, furnished specialties, and accessories.
- B. Product Certificates: Submit certificates of performance testing specified in "Source Quality Control" Article.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For emergency plumbing fixtures to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ANSI Standard: Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment."
- C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.
- D. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

PART 2 - PRODUCTS

2.1 EMERGENCY SHOWERS

- A. Emergency Showers:
 - 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Bradley Corporation.
 - b. Chicago Faucets.
 - c. Encon Safety Products.
 - d. Guardian Equipment Co.
 - e. Haws Corporation.
 - f. Speakman Company.
 - 2. Description: Plumbed, single-shower-head freestanding emergency shower.
 - a. Capacity: Deliver potable water at rate not less than 20 gpm for at least 15 minutes.
 - b. Supply Piping: NPS 1-1/4 galvanized steel, PVC with flow regulator and stay-open control valve.
 - c. Control-Valve Actuator: Pull rod.
 - d. Shower Head: 8-inch minimum diameter plastic.

2.2 EYE/FACE WASH EQUIPMENT

- A. Eye/Face Wash Equipment:
 - 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Bradley Corporation.
 - b. Encon Safety Products.
 - c. Guardian Equipment Co.
 - d. Speakman Company.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before plumbed emergency plumbing fixture installation.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EMERGENCY PLUMBING FIXTURE INSTALLATION

- A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.
- B. Install fixtures level and plumb.
- C. Fasten fixtures to substrate.

- D. Install shutoff valves in water-supply piping to fixtures. Use ball, gate, or globe valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
 - 1. Exception: Omit shutoff valve on supply to group of plumbing fixtures that includes emergency plumbing fixture.
 - 2. Exception: Omit shutoff valve on supply to emergency equipment if prohibited by authorities having jurisdiction.
- E. Install dielectric fitting in supply piping to fixture if piping and fixture connections are made of different metals. Dielectric fittings are specified in Division 22 Section "Common Work Results for Plumbing."
- F. Install trap and waste to wall on drain outlet of fixture receptors that are indicated to be directly connected to drainage system.
- G. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."
- H. Install equipment nameplates or equipment markers on fixtures and equipment signs on water-tempering equipment. Identification materials are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

3.4 FIELD QUALITY CONTROL

- A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities and temperatures.
- B. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.
- C. Report test results in writing.

3.5 ADJUSTING

- A. Adjust or replace fixture flow regulators for proper flow.
- B. Adjust equipment temperature settings.

END OF SECTION 22 4500

SECTION 22 5216 CONDENSING BOILERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes packaged, factory-fabricated and -assembled, gas-fired, fire-tube condensing boilers, trim, and accessories for generating hot water.

1.3 SUBMITTALS

- A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.
- E. Warranty: Special warranty specified in this Section.
- F. Other Informational Submittals:

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.
- C. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."
- D. UL Compliance: Test boilers for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

1.5 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

Project No. 121505 Condensing Boilers Section 22 5216 - 1

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Fire-Tube Condensing Boilers:
 - a. Leakage and Materials: 10 years from date of Substantial Completion.
 - b. Heat Exchanger Damaged by Thermal Stress and Corrosion: Nonprorated for five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - 1. AERCO International, Benchmark BMK-3.0LN
 - 2. Patterson-Kelly MACH C2500
 - 3. PVI Power VTX

2.2 MANUFACTURED UNITS

- A. Description: Factory-fabricated, -assembled, and -tested, fire-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Water heating service only.
- B. Heat Exchanger: Nonferrous, corrosion-resistant combustion chamber.
- C. Pressure Vessel: Carbon steel with welded heads and tube connections.
- D. Burner: Natural gas, forced draft.
- E. Blower: Centrifugal fan to operate during each burner firing sequence and to prepurge and postpurge the combustion chamber.
 - 1. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 - a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- F. Gas Train: Combination gas valve with manual shutoff and pressure regulator.
- G. Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision.
- H. Casing:
 - 1. Jacket: Sheet metal, with snap-in or interlocking closures.
 - 2. Control Compartment Enclosures: NEMA 250, Type 1A.

TLC Engineering Solutions

Project No. 121505 Condensing Boilers Section 22 5216 - 2

- 3. Finish: Baked-enamel protective finish.
- 4. Insulation: Minimum 2-inch- thick, mineral-fiber insulation surrounding the heat exchanger.
- 5. Combustion-Air Connections: Inlet and vent duct collars.
- 6. Mounting base to secure boiler.

2.3 TRIM

- A. Aquastat Controllers: Operating, firing rate and high limit.
- B. Safety Relief Valve: ASME rated.
- C. Pressure and Temperature Gage: Minimum 3-1/2-inch- diameter, combination waterpressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges so normal operating range is about 50 percent of full range.
- D. Boiler Air Vent: Automatic.
- E. Drain Valve: Minimum NPS 3/4 hose-end gate valve.
- F. Pumps:
 - 1. Provide dedicated pump and associated valves and accessories to serve each individual boiler.

2.4 CONTROLS

- A. Boiler operating controls shall include the following devices and features:
 - 1. Control transformer.
 - 2. Set-Point Adjust: Set points shall be adjustable.
 - Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to reset supply-water temperature inversely with outside-air temperature. At 0 deg F outside-air temperature, set supply-water temperature at 200 deg F; at 60 deg F outside-air temperature, set supply-water temperature at 140 deg F.
 - a. Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.
- B. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.
 - 1. High Cutoff: Automatic reset stops burner if operating conditions rise above maximum boiler design temperature.
 - 2. Low-Water Cutoff Switch: Float and electronic probe shall prevent burner operation on low water. Cutoff switch shall be manual reset type.
 - 3. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.

- C. Building Control System Interface: Factory install hardware and software to enable building automation system to monitor, control, and display boiler status and alarms.
 - 1. Hardwired Points:
 - a. Monitoring: On/off status, common trouble alarm, low water level alarm.
 - b. Control: On/off operation, hot water supply temperature set-point adjustment.
 - A communication interface with Building Control System in Section 23 0900 shall enable the operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through the Building Control System using BACNet MS/TP or TCP/IP communications network compatible with the Building Control System.

2.5 ELECTRICAL POWER

- A. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
 - 1. House in NEMA 250, Type 1 enclosure.
 - 2. Wiring shall be numbered and color-coded to match wiring diagram.
 - 3. Install factory wiring outside of an enclosure in a metal raceway.
 - 4. Field power interface shall be to wire lugs.
 - 5. Provide branch power circuit to each motor and to controls with a disconnect switch or circuit breaker.
 - 6. Provide each motor with overcurrent protection.

2.6 SOURCE QUALITY CONTROL

- A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
- B. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.
- C. Allow Owner access to source quality-control testing of boilers. Notify Architect 14 days in advance of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.
 - 1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- B. Examine mechanical spaces for suitable conditions where boilers will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BOILER INSTALLATION

- A. Install boilers level on concrete base. Concrete base is specified in Division 23 Section "Common Work Results for HVAC," and concrete materials and installation requirements are specified in Division 03.
- B. Vibration Isolation: Elastomeric isolation pads with a minimum static deflection of 0.25 inch. Vibration isolation devices and installation requirements are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- C. Install gas-fired boilers according to NFPA 54.
- D. Assemble and install boiler trim.
- E. Install electrical devices furnished with boiler but not specified to be factory mounted.
- F. Install control wiring to field-mounted electrical devices.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to boiler to allow service and maintenance.
- C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.
- D. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Division 22 Section "Common Work Results for Plumbing."
- E. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.
- F. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.
- G. Install piping from safety relief valves to nearest floor drain.
- H. Install piping from safety valves to drip-pan elbow and to nearest floor drain.
- I. Boiler Venting:
 - 1. Connect full size to boiler connections. Comply with requirements in Manufacturer's recommendations.
- J. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- K. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Perform installation and startup checks according to manufacturer's written instructions.
 - 2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
 - b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.
- E. Performance Tests:
 - 1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
 - 2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
 - 3. Perform field performance tests to determine capacity and efficiency of boilers.
 - a. Test for full capacity.
 - b. Test for boiler efficiency at low fire 20, 40, 60, 80, 100, 80, 60, 40, and 20 percent of full capacity. Determine efficiency at each test point.
 - 4. Repeat tests until results comply with requirements indicated.
 - 5. Provide analysis equipment required to determine performance.
 - 6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.

- 7. Notify Architect in advance of test dates.
- 8. Document test results in a report and submit to Architect.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain boilers. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 22 5216

SECTION 22 6113 MEDICAL AIR PIPING FOR HEALTHCARE FACILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Medical air piping and specialties designated "medical air," operating at 50 to 55 psig.

1.3 DEFINITIONS

- A. D.I.S.S.: Diameter-index safety system.
- B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- C. Medical Compressed-Air Piping Systems: Include medical air piping systems.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Medical compressed-air service connections.
 - 2. Medical compressed-air pressure control panels.
 - 3. Medical compressed-air alarm system components.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Piping Material Certification: Signed by Installer certifying that medical compressed-air piping materials comply with NFPA 99 requirements.
- D. Qualification Data: For installer and testing agency.
- E. Brazing certificates.
- F. Field quality-control test reports.
- G. Operation and Maintenance Data: For medical air piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Medical Compressed-Air Piping Systems for Healthcare Facilities: Qualify installers according to ASSE Standard #6010.

- 2. Pressure-Seal Joining Procedure for Copper Tubing: Qualify operators according to training provided by Viega; Plumbing and Heating Systems.
- B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the vacuum piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL, and that is acceptable to authorities having jurisdiction.
 - 1. Qualify testing personnel according to ASSE Standard #6020 for inspectors and ASSE Standard #6030 for verifiers.
- C. Source Limitations: Obtain compressed-air service connections of same type and from same manufacturer as service connections provided for in Division 22 Section "Gas Piping for Laboratory and Healthcare Facilities."
- D. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- F. ASME Compliance:
 - 1. Comply with ASME B31.1, "Power Piping," for laboratory compressed-air piping operating at more than 150 psig.
 - 2. Comply with ASME B31.9, "Building Services Piping," for laboratory compressedair piping operating at 150 psig or less.
- G. Comply with NFPA 99, "Health Care Facilities," for medical compressed-air system materials and installation in healthcare facilities.

1.6 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate medical compressed-air service connections with other service connections. Medical vacuum service connections are specified in Division 22 Section "Vacuum Piping for Laboratory and Healthcare Facilities," and medical gas service connections are specified in Division 22 Section "Gas Piping for Laboratory and Healthcare Facilities."

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Copper Medical Gas Tube: ASTM B 819, Types K and L, seamless, drawn temper that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in green for Type K tube and in blue for Type L tube.

- 1. General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.
- 2. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, with dimensions for brazed joints.
- 3. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.

2.2 JOINING MATERIALS

A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.3 VALVES

- A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.
- B. Ball Valves: MSS SP-110, 3-piece body, brass or bronze:
 - 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - a. Amico Corporation.
 - b. BeaconMedaes.
 - 2. Pressure Rating: 300 psig minimum.
 - 3. Ball: Full-port, chrome-plated brass.
 - 4. Seats: PTFE or TFE.
 - 5. Retain locking-type handle in first subparagraph below if required.
 - 6. Handle: Lever type with locking device.
 - 7. Stem: Blowout proof with PTFE or TFE seal.
 - 8. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
- C. Check Valves: In-line pattern, bronze:
 - 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - a. Amico Corporation.
 - b. BeaconMedaes.
 - 2. Pressure Rating: 300 psig minimum.
 - 3. Operation: Spring loaded.
 - 4. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
- D. Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.
 - 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Allied Healthcare Products, Inc.; Chemetron Div.

- b. Amico Corporation.
- c. BeaconMedaes.
- 2. Pressure Rating: 300 psig minimum.
- 3. Ball: Full-port, chrome-plated brass.
- 4. Seats: PTFE or TFE.
- 5. Handle: Lever type with locking device.
- 6. Stem: Blowout proof with PTFE or TFE seal.
- 7. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
- 8. Pressure Gage: Manufacturer installed on one copper-tube extension.
- E. Zone Valve Boxes: Formed steel with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gages and in sizes required to permit manual operation of valves.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Healthcare Products, Inc.; Chemetron Div.
 - b. Amico Corporation.
 - c. BeaconMedaes.
 - 2. Interior Finish: Factory-applied white enamel.
 - 3. Cover Plate: Satin-chrome finish steel with frangible or removable windows.
 - 4. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.
- F. Safety Valves: Bronze-body, ASME-construction, poppet, pressure-relief type with settings to match system requirements.
- G. Pressure Regulators: Bronze body and trim; spring-loaded, diaphragm-operated relieving type; manual pressure-setting adjustment; rated for 250-psig minimum inlet pressure; and capable of controlling delivered air pressure within 0.5 psig for each 10-psig inlet pressure.

2.4 MEDICAL COMPRESSED-AIR SERVICE CONNECTIONS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Amico Corporation.
 - b. BeaconMedaes.
- B. Connection Devices: For specific medical compressed-air pressure and service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.
 - 1. Roughing-in Assembly:
 - a. Steel outlet box for recessed mounting and concealed piping.

- b. Brass-body outlet block with secondary check valve that will prevent gas flow when primary valve is removed.
- c. Double seals that will prevent air leakage.
- d. ASTM B 819, NPS 3/8 copper outlet tube brazed to valve with service marking and tube-end dust cap.
- 2. Finishing Assembly:
 - a. Brass housing with primary check valve.
 - b. Double seals that will prevent air leakage.
 - c. Cover plate with gas-service label.
- 3. D.I.S.S. Service Connections: Pressure outlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.
 - a. Medical Air Service Connections: CGA V-5, D.I.S.S. No. 1160.
 - b. Instrument Air Service Connections: CGA V-5, D.I.S.S. No. 1160.
- 4. Cover Plates: One piece, metal, with chrome-plated finish and permanent, colorcoded, identifying label matching corresponding service.

2.5 MEDICAL COMPRESSED-AIR PRESSURE CONTROL PANELS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - 1. Amico Corporation.
 - 2. BeaconMedaes.
- B. Description: Steel box and support brackets for recessed roughing in with stainless-steel or anodized-aluminum cover plate with printed operating instructions. Include manifold assembly consisting of inlet supply valve, inlet supply pressure gage, line-pressure control regulator, outlet supply pressure gage, D.I.S.S. service connection, and piping outlet for remote service connection.
 - 1. Minimum Working Pressure: 200 psig.
 - 2. Line-Pressure Control Regulator: Self-relieving diaphragm type with precision manual adjustment.
 - 3. Pressure Gages: 0- to 300-psig range.
 - 4. Service Connection: CGA V-5, D.I.S.S. No. 1160, instrument air outlet.
 - 5. Before final assembly, provide temporary dust shield and U-tube for testing.
 - 6. Label cover plate "Air Pressure Control."

2.6 MEDICAL COMPRESSED-AIR-PIPING ALARM SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - 1. Amico Corporation.
 - 2. BeaconMedaes.
- B. Panels for medical compressed-air piping systems may be combined in single panels with medical vacuum and medical gas piping systems.

- C. Components: Designed for continuous service and to operate on power supplied from 120V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.
- D. Dew Point Monitors: Continuous line monitoring, having panel with gage or digital display, pipeline sensing element, electrical connections for alarm system, factory- or field-installed valved bypass, and visual and cancelable audio signal for dryer site and master alarm panels. Alarm signals when pressure dew point rises above 39 deg F at 55 psig.
- E. Pressure Switches or Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
 - 1. Low-Pressure Operating Range: 0- to 100-psig.
- F. Carbon Monoxide Monitors: Panel with gage or digital display, pipeline sensing element, electrical connections for alarm system, and factory- or field-installed valved bypass. Alarm signals when carbon monoxide level rises above 10 ppm.
- G. General Requirements for Medical Compressed-Air Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.
 - 1. Mounting: Recessed installation.
 - 2. Enclosures: Fabricated from minimum 0.047-inch- thick steel or minimum 0.05inch- thick aluminum, with knockouts for electrical and piping connections.
- H. Area Alarm Panels: Separate trouble alarm signals, pressure gages, and indicators for medical compressed-air piping systems.
 - 1. Include alarm signals when the following condition exists:
 - a. Medical Air: Pressure drops below 40 psig or rises above 60 psig.

2.7 COMPUTER INTERFACE CABINET

A. Description: Wall-mounting, welded-steel control cabinet with gasketed door, mounting brackets, grounding device, and white-enamel finish for connection of medical compressed-air- piping-system alarms to facility computer. Include factory-installed signal circuit boards, power transformer, circuit breaker, wiring terminal board, and internal wiring capable of interfacing 20 alarm signals.

2.8 FLEXIBLE PIPE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - 1. Flex-Hose Co., Inc.
 - 2. Flexicraft Industries.
 - 3. Metraflex, Inc.
- B. Description: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
 - 1. Working-Pressure Rating: 200 psig minimum.
 - 2. End Connections: Threaded copper pipe or plain-end copper tube.

2.9 SLEEVES

- A. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with set screws.

2.10 ESCUTCHEONS

- A. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to closely fit around pipe and tube and OD that completely covers opening.
- B. One-Piece, Cast-Brass Escutcheons: With set screw.
 - 1. Finish: Polished chrome-plated.

2.11 NITROGEN

A. Description: Comply with USP 28 - NF 23 for oil-free dry nitrogen.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing are not available or if precleaned fittings or tubing must be recleaned because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction perform the following procedures:
 - 1. Clean medical gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1, "Cleaning Equipment for Oxygen Service."
 - 2. Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb of chemical to 3 gal. of water.
 - a. Scrub to ensure complete cleaning.
 - b. Rinse with clean, hot water to remove cleaning solution.

3.2 PIPING APPLICATIONS

- A. Medical Air Piping: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
- B. Drain Piping: Use one of the following piping materials:
 - 1. Copper water tube, cast- or wrought-copper fittings, and soldered joints.

3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of compressed-air piping. Indicated locations and arrangements were used to size pipe and

calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

- B. Comply with ASSE Standard #6010 for installation of compressed-air piping.
- C. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
- F. Install piping adjacent to equipment and specialties to allow service and maintenance.
- G. Install air and drain piping with 1 percent slope downward in direction of flow.
- H. Install nipples, unions, special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications below unless otherwise indicated.
- I. Install eccentric reducers, if available, where compressed-air piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.
- J. Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.
- K. Install thermometer and pressure gage on discharge piping from each air compressor and on each receiver. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping."
- L. Install piping to permit valve servicing.
- M. Install piping free of sags and bends.
- N. Install fittings for changes in direction and branch connections.
- O. Install medical compressed-air piping to medical compressed-air service connections specified in this Section, to medical compressed-air service connections in equipment specified in Division 22 Section "Gas Piping for Laboratory and Healthcare Facilities," and to equipment specified in other Sections requiring medical compressed-air service.
- P. Install compressed-air service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.
- Q. Connect compressed-air piping to air compressors and to compressed-air outlets and equipment requiring compressed-air service.
- R. Install unions in copper compressed-air tubing adjacent to each valve and at final connection to each piece of equipment, machine, and specialty.

3.4 VALVE INSTALLATION

- A. Install shutoff valve at each connection to and from compressed-air equipment and specialties.
- B. Install check valves to maintain correct direction of compressed-air flow from compressed-air equipment.
- C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.
- D. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.

3.5 JOINT CONSTRUCTION

- A. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
- B. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter. Continuously purge joint with oil-free dry nitrogen during brazing.

3.6 MEDICAL COMPRESSED-AIR-PIPING ALARM SYSTEM INSTALLATION

- A. Alarm panels for medical compressed-air piping systems may be combined in single panels with medical vacuum piping systems and medical gas piping systems.
- B. Install alarm system components for medical compressed-air-piping according to and in locations required by NFPA 99.
- C. Install area alarm panels for medical compressed-air piping system where indicated.
- D. Install computer interface cabinet with connection to medical compressed-air-piping alarm system and to facility computer.

3.7 SLEEVE INSTALLATION

- A. Sleeves are not required for core-drilled holes.
- B. Permanent sleeves are not required for holes formed by removable PE sleeves.
- C. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs using stack sleeve fittings.
 - 1. Wall Penetrations: Cut sleeves to length for mounting flush with both surfaces.
 - 2. Floor Penetrations: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
- D. Install sleeves in new walls and slabs as new walls and slabs are constructed.

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.8 ESCUTCHEON INSTALLATION

- A. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. New Piping:
 - a. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
 - b. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.

3.9 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.
- B. Vertical Piping: MSS Type 8 or 42, clamps.
- C. Individual, Straight, Horizontal Piping Runs:
 - 1. 100 Feet and Less: MSS Type 1, adjustable, steel, clevis hangers.
 - 2. Longer than 100 Feet: MSS Type 43, adjustable, roller hangers.
- D. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for trapeze hangers.
- E. Base of Vertical Piping: MSS Type 52, spring hangers.
- F. Support horizontal piping within 12 inches of each fitting and coupling.
- G. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- H. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1/4: 60 inches with 3/8-inch rod.
 - 2. NPS 3/8 and NPS 1/2: 72 inches with 3/8-inch rod.
 - 3. NPS 3/4: 84 inches with 3/8-inch rod.
 - 4. NPS 1: 96 inches with 3/8-inch rod.
 - 5. NPS 1-1/4: 108 inches with 3/8-inch rod.
 - 6. NPS 1-1/2: 10 feet with 3/8-inch rod.
 - 7. NPS 2: 11 feet with 3/8-inch rod.
 - 8. NPS 2-1/2: 13 feet with 1/2-inch rod.
 - 9. NPS 3: 14 feet with 1/2-inch rod.
 - 10. NPS 3-1/2: 15 feet with 1/2-inch rod.
 - 11. NPS 4: 16 feet with 1/2-inch rod.

- 12. NPS 5: 18 feet with 1/2-inch rod.
- 13. NPS 6: 20 feet with 5/8-inch rod.
- 14. NPS 8: 23 feet with 3/4-inch rod.
- I. Install supports for vertical copper tubing every 10 feet.

3.10 LABELING AND IDENTIFICATION

- A. Install identifying labels and devices for nonmedical laboratory compressed-air piping, valves, and specialties. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment."
- B. Install identifying labels and devices for medical compressed-air piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:
 - 1. Medical Air: Black letters on yellow background.

3.11 FIELD QUALITY CONTROL FOR MEDICAL COMPRESSED-AIR PIPING IN HEALTHCARE FACILITIES

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections of medical compressed-air piping in healthcare facilities and prepare test reports.
- B. Tests and Inspections:
 - Medical Compressed-Air Testing Coordination: Perform tests, inspections, verifications, and certification of medical compressed-air piping systems concurrently with tests, inspections, and certification of medical vacuum piping and medical gas piping systems.
 - 2. Preparation: Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:
 - a. Initial blowdown.
 - b. Initial pressure test.
 - c. Cross-connection test.
 - d. Piping purge test.
 - e. Standing pressure test for positive-pressure medical compressed-air piping.
 - f. Repair leaks and retest until no leaks exist.
 - 3. System Verification: Comply with requirements in NFPA 99, ASSE Standard #6020, and ASSE Standard #6030 for verification of medical compressed-air piping systems and perform the following tests and inspections:
 - a. Standing pressure test.
 - b. Individual-pressurization or pressure-differential cross-connection test.
 - c. Valve test.
 - d. Master and area alarm tests.
 - e. Piping purge test.
 - f. Piping particulate test.
 - g. Piping purity test.
 - h. Final tie-in test.
 - i. Operational pressure test.

- j. Medical air purity test.
- k. Verify correct labeling of equipment and components.
- 4. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
 - a. Inspections performed.
 - b. Procedures, materials, and gases used.
 - c. Test methods used.
 - d. Results of tests.
- C. Remove and replace components that do not pass tests and inspections and retest as specified above.

3.12 DEMONSTRATION

A. Engage factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain medical compressed-air alarm systems. Refer to Division 01 Section "Demonstration and Training."

END OF DOCUMENT 22 6113

SECTION 22 6119 MEDICAL AIR EQUIPMENT FOR HEALTHCARE FACILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Packaged, oil-free reciprocating air compressors.
 - 2. Inlet-air filters.
 - 3. Desiccant compressed-air dryers.
 - 4. Compressed-air purification systems.
 - 5. Compressed-air filter assemblies.
 - 6. Medical compressed-air equipment alarm systems.

1.3 DEFINITIONS

- A. Actual Air: Air delivered at air-compressor outlet. Flow rate is compressed air delivered and measured in acfm.
- B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- C. Medical Air Equipment: Compressed-air equipment and accessories for healthcare facilities.
- D. Standard Air: Free air at 68 deg F and 1 atmosphere before compression or expansion and measured in scfm.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 1. Wiring Diagrams: For power, signal, and control wiring.
- B. Qualification Data: For qualified Installer and testing agency.
- C. Field quality-control reports.
- D. Operation and Maintenance Data: For compressed-air equipment to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Medical Air System Equipment for Healthcare Facilities: Qualify installers according to ASSE 6010.

- B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the compressed-air equipment testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL and that is acceptable to authorities having jurisdiction.
 - 1. Qualify testing personnel according to ASSE 6020 for inspectors and ASSE 6030 for verifiers.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. ASME Compliance: Fabricate and label receivers to comply with ASME Boiler and Pressure Vessel Code.
- E. Comply with NFPA 99, "Health Care Facilities," for compressed-air equipment and accessories for medical air systems.
- F. Comply with UL 544, "Medical and Dental Equipment," for medical compressed-air equipment.

1.6 COORDINATION

A. Coordinate sizes and locations of concrete bases with equipment provided.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PACKAGED AIR COMPRESSORS

- A. Description: Factory-assembled, -wired, -piped, and -tested; electric-motor-driven; air-cooled; continuous-duty air compressors and receivers that deliver air of quality equal to intake air.
- B. Control Panels: Automatic control station with load control and protection functions. Comply with NEMA ICS 2 and UL 508.
 - 1. Enclosure: NEMA ICS 6, Type 12 control panel unless otherwise indicated.
 - 2. Motor Controllers: Full-voltage, combination-magnetic type with undervoltage release feature and motor-circuit-protector-type disconnecting means and short-circuit protective device.
 - 3. Control Voltage: 120-V ac or less, using integral control power transformer.
 - 4. Motor Overload Protection: Overload relay in each phase.
 - 5. Starting Devices: Hand-off-automatic selector switch in cover of control panel, plus pilot device for automatic control.
 - 6. Automatic control switches to alternate lead-lag air compressors for duplex and sequence lead-lag air compressors for multiplex air compressors.
 - 7. Instrumentation: Include discharge-air and receiver pressure gages, air-filter maintenance indicator, hour meter, air-compressor discharge-air and coolant temperature gages, and control transformer.

- 8. Alarm Signal Device: For connection to alarm system to indicate when backup air compressor is operating.
- 9. Short Circuit Rating: Entire control panel assembly shall have a short circuit current rating of no less than 65,000 amperes symmetrical at 480V.
- C. Receivers: Steel tank constructed according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
 - 1. Pressure Rating: At least as high as highest discharge pressure of connected air compressors and bearing appropriate code symbols.
 - 2. Interior Finish: Corrosion-resistant coating.
 - 3. Accessories: Include safety valve, pressure gage, automatic drain, and pressure regulator.
- D. Mounting Frame: Fabricate base and attachment to pressure vessel with reinforcement strong enough to resist packaged equipment movement during a seismic event when base is anchored to building structure.

2.2 INLET-AIR FILTERS

- A. Description: Combination inlet-air filter-silencer, suitable for remote installation, for each air compressor.
 - 1. Construction: Weatherproof housing for replaceable, dry-type filter element, with silencer tubes or other method of sound reduction.
 - 2. Capacity: Match capacity of air compressor, with collection efficiency of 99 percent retention of particles larger than 10 micrometers.

2.3 DESICCANT COMPRESSED-AIR DRYERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Amico, Inc.
 - 2. BeaconMedaes.
- B. Description: Twin-tower unit with purge system, mufflers, and capability to deliver plus 10 deg F, 100-psig air at dew point. Include dew point controlled purge, step-down transformers, disconnect switches, inlet and outlet pressure gages, thermometers, automatic controls, and filters.

2.4 COMPRESSED-AIR PURIFICATION SYSTEMS

- A. Manufacturers: Purification system is part of the packaged medical air compressor.
- B. Description: Compressed-air purification system sized for maximum connected equipment capacity with coalescing, particulate, and activated-charcoal filters; compressed-air dryer; catalytic converter; gages and thermometers; and controls.
 - 1. Include the following capabilities:
 - a. Removal of excessive moisture, solid particulates, oil and oil mist, carbon monoxide, and hydrocarbon vapors.

- b. Automatic ejection of condensate from airstream.
- c. Production of air complying with USP NF for medical air.
- d. Capacity and dew point indicated, but not higher than 35 deg F at 100 psig.
- 2. Filters: Parallel duplex filters, each sized for maximum system demand, with valved bypass for filter servicing.
 - a. Inlet Filters: 5 micrometers.
 - b. Outlet Filters: 1 micrometer(s).
- 3. Accessories: Inlet and outlet pressure gages, thermometers, safety valves, and shutoff valves; and automatic ejection of condensate from airstream.
- 4. Differential Pressure Switch: Adjustable, diaphragm type, with electrical connections for alarm system, to indicate when air-pressure drop through filters rises to more than 2 psig greater than when new and clean.
 - a. Inlet Connection: From inlet to particulate filter.
 - b. Outlet Connection: To outlet from final activated-charcoal filter.
- 5. Compressed-Air Dryer: Twin-tower desiccant type with automatic controls, purge system and mufflers.

2.5 COMPRESSED-AIR FILTER ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Arrow Pneumatics, Inc.
 - 2. Dollinger.
 - 3. Domnick Hunter Limited; ZANDER, Inc.
 - 4. Donaldson Company, Inc.; Donaldson Ultrafilter Co.
 - 5. EMSE Corporation.
 - 6. Ingersoll-Rand; Air Solutions Group.
 - 7. Kaeser Compressors, Inc.
 - 8. Pioneer Air Systems, Inc.
 - 9. SPX Air Treatment.
 - 10. Van Air Systems, Inc.
 - 11. Zeks Compressed Air Solutions.
- B. Description: Filter assemblies suitable for compressed air, in parallel duplex arrangement. Size each assembly for maximum capacity of connected equipment and operating pressure of compressed-air system. Include automatic ejection of condensate from airstream, inlet and outlet pressure gages, and shutoff valves.
 - 1. Option: Factory-fabricated filter system consisting of three air filters equivalent to those specified, pipe, fittings, valves, differential pressure switch, and enclosure; and with additional automatic drain traps and gages.
 - 2. Size filter assemblies for 5-psig maximum air-pressure drop when filters are new and clean, at system rated capacity, and at 100-psig pressure.

- 3. Differential Pressure Switch: Adjustable, diaphragm type, with electrical connections for alarm system, to indicate when air-pressure drop through filters rises to more than 2 psig greater than when new and clean.
- 4. Particulate Filters: Collection efficiency of 98 percent retention of particles 1 micrometer and larger.
- 5. Odor and Taste Filters: Vapor-absorbing, activated charcoal.
- 6. Coalescing Filters: Collection efficiency of 99.9 percent retention of particles 0.3 micrometer and smaller.
- 7. Include automatic drain trap for each filter.

2.6 MEDICAL COMPRESSED-AIR EQUIPMENT ALARM SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Amico Corporation.
 - 2. BeaconMedaes.
- B. General Requirements for Medical Compressed-Air Equipment Alarm System: Compatible alarm panels, remote sensing devices, and other related components as required by NFPA 99 for Level 1 alarm systems. Refer to Division 22 Section "Compressed-Air Piping for Laboratory and Healthcare Facilities" for medical compressed-air piping and alarm systems. Power wiring is specified in Division 26 Sections.
- C. Components: Designed for continuous service and to operate on power supplied from 120-V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.
- D. Dew Point Monitors: Continuous line monitoring, having panel with gage or digital display, pipeline sensing element, electrical connections for alarm system, factory- or field-installed valved bypass, and visual and cancelable audio signal for dryer site and master alarm panels. Alarm signals when pressure dew point rises above 39 deg F at 55 psig.
- E. Pressure Switches or Pressure Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
 - 1. Low-Pressure Switches: 0- to 100-psig operating range.
 - 2. High-Pressure Switches: Up to 250-psig operating range.
- F. Carbon Monoxide Monitors: Panel with gage or digital display, pipeline sensing element, electrical connections for alarm system, and factory- or field-installed valved bypass. Alarm signals when carbon monoxide level rises above 10 ppm.
- G. General Requirements for Medical Compressed-Air Equipment Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions:
 - 1. Mounting: Recessed installation.
 - 2. Enclosures: Fabricated from minimum 0.047-inch- thick steel or minimum 0.05-inchthick aluminum, with knockouts for electrical and piping connections.

- H. Local and Master Alarm Panels: Separate trouble alarm signals and pressure gages to indicate function of medical compressed-air equipment when the following conditions exist:
 - 1. Medical Air, Compressed-Air Equipment: Pressure drops below 40 psig or rises above 60 psig, backup air compressor is in operation, pressure drop across filter assembly increases more than 2 psig, dew point rises above 39 deg F at 55 psig, carbon monoxide level rises above 10 ppm, and the following:
 - a. Oil-Free Air-Compressor Equipment: High discharge-air temperature and high water level in receiver.

2.7 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 22 Section "Common Motor Requirements for Plumbing Equipment."
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

PART 3 - EXECUTION

3.1 **PREPARATION**

A. Clean compressed-air equipment, accessories, and components that have not been cleaned for oxygen service and sealed or that are furnished unsuitable for laboratory air and medical air applications, according to CGA G-4.1, "Cleaning Equipment for Oxygen Service."

3.2 COMPRESSED-AIR EQUIPMENT INSTALLATION

- A. General Requirements for Compressed-Air Equipment Installation:
 - 1. Install compressed-air equipment to allow maximum headroom unless specific mounting heights are indicated.
 - 2. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces unless otherwise indicated.
 - 3. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
 - 4. Install equipment to allow right of way for piping installed at required slope.
 - 5. Install the following devices on compressed-air equipment:
 - a. Thermometer, Pressure Gage, and Safety Valve: Install on each compressed-air receiver.

- b. Pressure Regulators: Install downstream from air compressors, dryers, purification units, and filter assemblies.
- c. Drain Valves: Install on aftercoolers, receivers, and dryers. Discharge condensate over nearest floor drain.
- B. Medical Compressed-Air Equipment Installation:
 - 1. Install according to ASSE 6010 and NFPA 99.
 - 2. Install compressed-air equipment, except wall-mounting equipment, on concrete bases. Install units anchored to substrate in locations indicated. Maintain manufacturers' recommended clearances. Orient equipment so controls and devices are accessible for servicing.
 - a. Anchor equipment to concrete bases according to manufacturer's written instructions.
 - 1) For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 2) Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 3) Install anchor bolts to elevations required for proper attachment to supported equipment.
 - b. Vibration Isolation: Mount equipment on a vibration isolation equipment base as specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

3.3 MEDICAL COMPRESSED-AIR EQUIPMENT ALARM SYSTEM INSTALLATION

- A. Alarm panels for medical compressed-air equipment may be combined in single panels with medical vacuum equipment and medical gas piping systems.
- B. Install medical compressed-air equipment alarm system components in locations required by and according to NFPA 99.
- C. Install medical compressed-air equipment local and master alarm panels where indicated.

3.4 BCS INTERFACE INSTALLATION

A. Install Building Control System interface cabinet with connection to medical compressed-air piping alarm system and to facility computer.

3.5 CONNECTIONS

- A. Comply with requirements for water-supply piping specified in Division 22 Section "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Comply with requirements for drain piping specified in Division 22 Section "Sanitary Waste and Vent Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- C. Comply with requirements for compressed-air piping specified in Division 22 Section "Compressed-Air Piping for Laboratory and Healthcare Facilities." Drawings indicate general arrangement of piping, fittings, and specialties.
- D. Install piping adjacent to equipment to allow service and maintenance.
- E. Connect compressed-air piping to compressed-air equipment, accessories, and specialties with shutoff valve and union or flanged connection.
- F. Connect water supply to compressed-air equipment that requires water. Include backflow preventer. Backflow preventers are specified in Division 22 Section "Domestic Water Piping Specialties."

3.6 IDENTIFICATION

- A. Identify nonmedical laboratory compressed-air equipment system components. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."
- B. Identify medical compressed-air equipment system components. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment." and comply with NFPA 99.

3.7 FIELD QUALITY CONTROL FOR HEALTHCARE-FACILITY MEDICAL COMPRESSED-AIR EQUIPMENT

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
 - 1. Medical Compressed-Air Equipment Testing Coordination: Perform tests, inspections, verifications, and certification of medical compressed-air equipment concurrently with tests, inspections, and certification of medical vacuum equipment, medical vacuum piping, medical compressed-air piping and medical gas piping systems.
 - 2. Preparation: Perform medical compressed-air equipment tests according to requirements in NFPA 99 for the following:
 - a. Air-quality purity test.
 - b. System operation test.
 - 3. Equipment Verification: Comply with requirements in ASSE 6020, ASSE 6030, and NFPA 99 for verification of medical compressed-air equipment.
 - 4. Replace damaged and malfunctioning controls and equipment.
 - 5. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
 - a. Inspections performed.
 - b. Procedures, materials, and gases used.
 - c. Test methods used.
 - d. Results of tests.

- C. Components will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.8 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Check belt drives for proper tension.
 - 3. Verify that air-compressor inlet filters and piping are clear.
 - 4. Check for equipment vibration-control supports and flexible pipe connectors and verify that equipment is properly attached to substrate.
 - 5. Check safety valves for correct settings. Ensure that settings are higher than aircompressor discharge pressure but not higher than rating of system components.
 - 6. Check for proper seismic restraints.
 - 7. Drain receiver tanks.
 - 8. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 9. Test and adjust controls and safeties.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air compressors, compressed-air dryers, compressed-air purification units and compressed-air filter assemblies.

END OF SECTION 22 6119

SECTION 22 6213 VACUUM PIPING FOR HEALTHCARE FACILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Medical surgical vacuum piping and specialties designated "medical vacuum" operating at 15 inches mercury.
 - 2. Waste anesthetic gas disposal piping and specialties, designated "WAGD evacuation" operating at 14 inches mercury.

1.2 **DEFINITIONS**

- A. D.I.S.S.: Diameter-index safety system.
- B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- C. WAGD: Waste anesthetic gas disposal.
- D. Medical vacuum piping systems include medical vacuum and WAGD evacuation piping systems.

1.3 SUBMITTALS

- A. Product Data: For the following:
 - 1. Vacuum and fittings.
 - 2. Vacuum valves and valve boxes.
 - 3. Medical vacuum service connections and vacuum-bottle brackets.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Piping Material Certification: Signed by Installer certifying that medical vacuum piping materials comply with NFPA 99 requirements.
- D. Qualification Data: For Installer and testing agency.
- E. Brazing certificates.
- F. Field quality-control test reports.
- G. Operation and Maintenance Data: For vacuum piping specialties to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Medical Vacuum Piping Systems for Healthcare Facilities: Qualify installers according to ASSE Standard #6010.
- B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the vacuum piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL, and that is acceptable to authorities having jurisdiction.
 - 1. Qualify testing personnel according to ASSE Standard #6020 for inspectors and ASSE Standard #6030 for verifiers.
- C. Source Limitations: Obtain vacuum service connections of same type and from same manufacture as service connections provided for in Division 22 Section "Gas Piping for Laboratory and Healthcare Facilities."
- D. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- F. Comply with ASME B31.9, "Building Services Piping," for vacuum piping in laboratory facilities.
- G. NFPA Compliance: Comply with NFPA 99, "Health Care Facilities," for medical vacuum system materials and installation in healthcare facilities.

1.5 COORDINATION

A. Coordinate medical vacuum service connections with other service connections. Medical compressed-air service connections are specified in Division 22 Section "Compressed-Air Piping for Laboratory and Healthcare Facilities," and medical gas service connections are specified in Division 22 Section "Gas Piping for Laboratory and Healthcare Facilities."

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

- Copper Medical Gas Tube: ASTM B 819, Type L, seamless, drawn temper that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED,"
 "OXY/MED," "OXY/ACR," or "ACR/MED" in blue.
 - 1. General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.
 - 2. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, with dimensions for brazed joints.

- 3. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.
- B. Copper Water Tube: ASTM B 88, Type M, seamless, drawn temper.
 - 1. Cast-Copper Fittings: ASME B16.18, solder-joint pressure type.
 - 2. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type.
 - 3. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150.
 - 4. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.

2.2 JOINING MATERIALS

- A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.

2.3 VALVES

- A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.
 - 1. Exception: Factory cleaning and bagging are not required for valves for WAGD service.
- B. Copper-Alloy Ball Valves: MSS SP-110, 3-piece body, brass or bronze.
 - 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - a. Amico Corporation.
 - b. BeaconMedaes.
 - 2. Pressure Rating: 300 psig minimum.
 - 3. Ball: Full-port, chrome-plated brass.
 - 4. Seats: PTFE or TFE.
 - 5. Handle: Lever type with locking device.
 - 6. Stem: Blowout proof with PTFE or TFE seal.
 - 7. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
- C. Bronze Check Valves: In-line pattern.
 - 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - a. Amico Corporation.
 - b. BeaconMedaes.
 - 2. Pressure Rating: 300 psig minimum.
 - 3. Operation: Spring loaded.
 - 4. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

- D. Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.
 - 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - a. Amico Corporation.
 - b. BeaconMedaes.
 - 2. Pressure Rating: 300 psig minimum.
 - 3. Ball: Full-port, chrome-plated brass.
 - 4. Seats: PTFE or TFE.
 - 5. Handle: Lever type with locking device.
 - 6. Stem: Blowout proof with PTFE or TFE seal.
 - 7. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
 - 8. Vacuum Gage: Manufacturer installed on one copper-tube extension.
- E. Zone Valve Boxes: Formed steel with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with vacuum gages and in sizes required to permit manual operation of valves.
 - 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - a. Amico Corporation.
 - b. BeaconMedaes.
 - 2. Interior Finish: Factory-applied white enamel.
 - 3. Cover Plate: Satin-chrome finish steel with frangible or removable windows.
 - 4. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.
- F. Safety Valves: Bronze-body, ASME-construction, pressure-relief type with settings to match system requirements.
- G. Butterfly valves are not allowed.

2.4 MEDICAL VACUUM SERVICE CONNECTIONS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - 1. Amico Corporation.
 - 2. BeaconMedaes.
- B. Connection Devices: For specific medical vacuum service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.
 - 1. Roughing-in Assembly:
 - a. Steel outlet box for recessed mounting and concealed piping.
 - b. Brass-body inlet block.

- c. Seals that will prevent vacuum leakage.
- d. ASTM B 819, NPS 3/8 copper outlet tube brazed to valve with service marking and tube-end dust cap.
- 2. Finishing Assembly:
 - a. Brass housing with primary check valve.
 - b. Seals that will prevent vacuum leakage.
 - c. Cover plate with gas-service label.
- 3. Quick-Coupler Service Connections: Suction inlets for medical vacuum and WAGD evacuation service outlets with noninterchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.
- 4. D.I.S.S. Service Connections: Suction inlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.
 - a. Medical Vacuum Service Connections: CGA V-5, D.I.S.S. No. 1220.
 - b. WAGD Evacuation Service Connections: CGA V-5, D.I.S.S. No. 2220.
- 5. Vacuum Bottle Brackets: One piece, with pattern and finish matching corresponding service cover plate.
- 6. Cover Plates: One piece, stainless steel, with NAAMM AMP 503, No. 4 finish and permanent, color-coded, identifying label matching corresponding service.

2.5 MEDICAL VACUUM PIPING ALARM SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - 1. Amico Corporation.
 - 2. BeaconMedaes.
- B. Panels for medical vacuum piping systems may be combined in single panels with medical compressed-air and medical gas piping systems.
- C. Components: Designed for continuous service and to operate on power supplied from 120-V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.
- D. Vacuum Switches or Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
 - 1. Vacuum Operating Range: 0- to 30-in. Hg.
- E. General Requirements for Medical Vacuum Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.
 - 1. Mounting: Recessed installation.

- 2. Enclosures: Fabricated from minimum 0.047-inch- thick steel or minimum 0.05inch- thick aluminum, with knockouts for electrical and piping connections.
- F. Master Alarm Panels: With separate trouble alarm signals, vacuum gages, and indicators for medical vacuum piping systems.
 - 1. Include alarm signals when the following conditions exist:
 - a. Medical Vacuum: Vacuum drops below 12-in. Hg and backup vacuum pump is in operation.
 - b. WAGD Evacuation: Vacuum drops below 12-in. Hg.
- G. Anesthetizing-Area Alarm Panels: Separate trouble alarm signals; vacuum gages; and indicators for medical vacuum piping systems.
 - 1. Include alarm signals when the following conditions exist:
 - a. Medical Vacuum: Vacuum drops below 12-in. Hg.
 - b. WAGD Evacuation: Vacuum drops below 12-in. Hg.
- H. Area Alarm Panels: Separate trouble alarm signals; vacuum gages; and indicators for medical vacuum piping systems.
 - 1. Include alarm signals when the following condition exists:
 - a. Medical Vacuum: Vacuum drops below 12-in. Hg.

2.6 COMPUTER INTERFACE CABINET

A. Description: Wall-mounting, welded-steel, control cabinet with gasketed door, mounting brackets, grounding device, and white-enamel finish for connection of medical vacuum piping system alarms to facility computer. Include factory-installed signal circuit boards, power transformer, circuit breaker, wiring terminal board, and internal wiring capable of interfacing 20 alarm signals.

2.7 ESCUTCHEONS

- A. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to closely fit around pipe and tube and OD that completely covers opening.
- B. One-Piece, Cast-Brass Escutcheons: With set screw.
 - 1. Finish: Polished chrome-plated.

2.8 NITROGEN

A. Description: Comply with USP 28 - NF 23 for oil-free dry nitrogen.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing are not available or if precleaned fittings or tubing must be recleaned because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction perform the following procedures:
 - 1. Clean medical gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1, "Cleaning Equipment for Oxygen Service."
 - 2. Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb of chemical to 3 gal. of water.
 - a. Scrub to ensure complete cleaning.
 - b. Rinse with clean, hot water to remove cleaning solution.

3.2 PIPING APPLICATIONS

- A. Medical Vacuum Piping: Use the following piping materials for each size range:
 - 1. NPS 4 and Smaller: Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
- B. WAGD Evacuation Piping: Use the following piping materials for each size range:
 - 1. NPS 4 and Smaller: Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
- C. Drain Piping: Use the following piping materials:
 - 1. Copper water tube, cast- or wrought-copper fittings, and soldered joints.

3.3 PIPING INSTALLATION

- Drawing plans, schematics, and diagrams indicate general location and arrangement of vacuum piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Comply with ASSE Standard #6010 for installation of vacuum piping.
- C. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
- F. Install piping adjacent to equipment and specialties to allow service and maintenance.
- G. Install vacuum and drain piping with 1 percent slope downward in direction of flow.
- H. Install nipples, unions, and special fittings, and valves with pressure ratings same as or higher than piping pressure rating used in applications below unless otherwise indicated.
- I. Install eccentric reducers, if available, where vacuum piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.
- J. Provide drain leg and drain trap at end of each main and branch and at low points.
- K. Install thermometer and vacuum gage on inlet piping to each vacuum producer and on each receiver and separator. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping."
- L. Install piping to permit valve servicing.
- M. Install piping free of sags and bends.
- N. Install fittings for changes in direction and for branch connections. Extruded-tee branch outlets in copper tubing may be made where specified.
- O. Install medical vacuum piping to medical vacuum service connections specified in this Section and to equipment specified in other Sections requiring medical vacuum service.
- P. Install medical vacuum service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.
- Q. Install medical vacuum bottle bracket adjacent to each wall-mounted medical vacuum service connection suction inlet.
- R. Connect vacuum piping to vacuum producers and to equipment requiring vacuum service.
- S. Install unions, in copper vacuum tubing adjacent to each valve and at final connection to each piece of equipment, machine, and specialty.

3.4 VALVE APPLICATIONS

A. Valves for Copper Vacuum Tubing: Use copper alloy ball and bronze check types.

3.5 VALVE INSTALLATION

- A. Install shutoff valve at each connection to and from vacuum equipment and specialties.
- B. Butterfly valves shall not be used in the vacuum system.
- C. Install check valves to maintain correct direction of vacuum flow to vacuum-producing equipment.

- D. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.
- E. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.
- F. Install safety valves on vacuum receivers, where required by NFPA 99, and where recommended by specialty manufacturers.
- G. Install flexible pipe connectors in suction inlet piping to each vacuum producer.

3.6 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter. Continuously purge joint with oil-free dry nitrogen during brazing.
- E. Soldered Joints: Apply ASTM B 813, water-flushable flux to tube end. Join copper tube and fittings according to ASTM B 828.

3.7 MEDICAL VACUUM PIPING ALARM SYSTEM INSTALLATION

- A. Panels for medical vacuum piping systems may be combined in single panels with medical compressed-air piping systems and medical gas piping systems.
- B. Install medical vacuum piping system alarm system components in locations required by and according to NFPA 99.
- C. Install medical vacuum piping system area and master alarm panels where indicated.
- D. Install computer interface cabinet with connection to medical vacuum piping alarm system and to facility computer.

3.8 ESCUTCHEON INSTALLATION

- A. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. New Piping:
 - a. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
 - b. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.

3.9 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.
- B. Vertical Piping: MSS Type 8 or 42 clamps.
- C. Individual, Straight, Horizontal Piping Runs:
 - 1. 100 Feet and Less: MSS Type 1, adjustable, steel, clevis hangers.
 - 2. Longer Than 100 Feet: MSS Type 43, adjustable, roller hangers.
- D. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for trapeze hangers.
- E. Base of Vertical Piping: MSS Type 52, spring hangers.
- F. Support horizontal piping within 12 inches of each fitting and coupling.
- G. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- H. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1/4: 60 inches with 3/8-inch rod.
 - 2. NPS 3/8 and NPS 1/2: 72 inches with 3/8-inch rod.
 - 3. NPS 3/4: 84 inches with 3/8-inch rod.
 - 4. NPS 1: 96 inches with 3/8-inch rod.
 - 5. NPS 1-1/4: 108 inches with 3/8-inch rod.
 - 6. NPS 1-1/2: 10 feet with 3/8-inch rod.
 - 7. NPS 2: 11 feet with 3/8-inch rod.
 - 8. NPS 2-1/2: 13 feet with 1/2-inch rod.
 - 9. NPS 3: 14 feet with 1/2-inch rod.
 - 10. NPS 3-1/2: 15 feet with 1/2-inch rod.
 - 11. NPS 4: 16 feet with 1/2-inch rod.
 - 12. NPS 5: 18 feet with 1/2-inch rod.
 - 13. NPS 6: 20 feet with 5/8-inch rod.
 - 14. NPS 8: 23 feet with 3/4-inch rod.
- I. Install supports for vertical copper tubing every 10 feet.

3.10 LABELING AND IDENTIFICATION

- A. Install identifying labels and devices for laboratory vacuum piping, valves, and specialties. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment."
- B. Install identifying labels and devices for medical vacuum piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:
 - 1. Medical Vacuum: Black letters on white background.
 - 2. WAGD: White letters on violet background.

3.11 FIELD QUALITY CONTROL FOR LABORATORY FACILITY NONMEDICAL VACUUM PIPING

- A. Testing Agency: Engage qualified testing agency to perform field tests and inspections of vacuum piping in nonmedical laboratory facilities.
- B. Tests and Inspections:
 - 1. Piping Leak Tests for Vacuum Piping: Test new and modified parts of existing piping. Cap and fill vacuum piping with oil-free, dry nitrogen. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
 - a. Test Pressure for Copper Tubing: 150 psig.
 - 2. Repair leaks and retest until no leaks exist.
 - 3. Inspect filters for proper operation.
- C. Prepare test reports.

3.12 FIELD QUALITY CONTROL FOR HEALTHCARE FACILITY MEDICAL VACUUM PIPING

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections of medical vacuum piping systems in healthcare facilities and prepare test reports.
- B. Tests and Inspections:
 - 1. Medical Vacuum Testing Coordination: Perform tests, inspections, verifications, and certification of medical vacuum piping systems concurrently with tests, inspections, and certification of medical compressed-air piping and medical gas piping systems.
 - 2. Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:
 - a. Initial blow down.
 - b. Initial pressure test.
 - c. Cross-connection test.
 - d. Piping purge test.
 - e. Standing pressure test for vacuum systems.
 - f. Repair leaks and retest until no leaks exist.
 - System Verification: Comply with requirements in NFPA 99, ASSE Standard #6020, and ASSE Standard #6030 for verification of medical vacuum piping systems and perform the following tests and inspections:
 - a. Standing pressure test.
 - b. Individual-pressurization or pressure-differential cross-connection test.
 - c. Valve test.
 - d. Master and area alarm tests.
 - e. Piping purge test.
 - f. Final tie-in test.
 - g. Operational vacuum test.
 - h. Verify correct labeling of equipment and components.

- 4. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
 - a. Inspections performed.
 - b. Procedures, materials, and gases used.
 - c. Test methods used.
 - d. Results of tests.
- C. Remove and replace components that do not pass tests and inspections and retest as specified above.

3.13 DEMONSTRATION

A. Engage factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain medical vacuum alarm systems. Refer to Division 01 Section "Demonstration and Training."

END OF DOCUMENT 22 6213

SECTION 22 6219 VACUUM EQUIPMENT FOR HEALTHCARE FACILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Packaged, oil-free, rotary, sliding-vane vacuum pumps.
 - 2. Medical vacuum equipment alarm systems.

1.3 **DEFINITIONS**

- A. Actual Air: Air delivered at vacuum producer inlet. Flow rate is air measured in expanded cfm.
- B. HVE: High-volume oral evacuation for dental applications in healthcare facilities.
- C. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- D. Medical vacuum equipment includes medical vacuum and WAGD evacuation equipment and accessories for healthcare facilities.
- E. Standard Air: Free air at 68 deg F and 1 atmosphere before compression or expansion and measured in scfm.
- F. WAGD Evacuation: Waste anesthetic gas disposal for medical-surgical applications in healthcare facilities.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 1. Wiring Diagrams: For power, signal, and control wiring.
- B. Qualification Data: For qualified Installer and testing agency.
- C. Field quality-control reports.
- D. Operation and Maintenance Data: For vacuum equipment to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Medical Vacuum System Equipment for Healthcare Facilities: Qualify installers according to ASSE 6010.

- B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the vacuum equipment testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL, and that is acceptable to authorities having jurisdiction.
 - 1. Qualify testing personnel according to ASSE 6020 for inspectors and ASSE 6030 for verifiers.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. ASME Compliance: Fabricate and label receivers and separators to comply with ASME Boiler and Pressure Vessel Code.
- E. Comply with NFPA 99, "Health Care Facilities," for vacuum equipment and accessories for medical vacuum systems.
- F. Comply with UL 544, "Medical and Dental Equipment," for medical vacuum equipment.

1.6 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PACKAGED VACUUM PUMPS

- A. Description: Factory-assembled, -wired, -piped, and -tested; electric-motor-driven; air-cooled; continuous-duty vacuum pumps and receivers.
- B. Control Panels: Automatic control station with load control and protection functions. Comply with NEMA ICS 2 and UL 508.
 - 1. Enclosure: NEMA ICS 6, Type 12 control panel unless otherwise indicated.
 - 2. Motor Controllers: Full-voltage, combination-magnetic type with undervoltage release feature and motor-circuit-protector-type disconnecting means and short-circuit protective device.
 - 3. Control Voltage: 120-V ac or less, using integral control power transformer.
 - 4. Motor Overload Protection: Overload relay in each phase.
 - 5. Starting Devices: Hand-off-automatic selector switch in cover of control panel, plus pilot device for automatic control.
 - 6. Automatic control switches to alternate lead-lag vacuum pumps for duplex and sequence lead-lag vacuum pumps for multiplex vacuum pumps.
 - 7. Instrumentation: Include vacuum pump inlet and receiver vacuum gages, hour meter, vacuum pump discharge-air and coolant temperature gages, and control transformer.
 - 8. Alarm Signal Device: For connection to alarm system to indicate when backup vacuum pump is operating.
 - 9. Short Circuit Rating: Entire control panel assembly shall have a short circuit current rating of no less than 65,000 amperes symmetrical at 480V.
- C. Receivers: Steel tank constructed according to ASME Boiler and Pressure Vessel Code, Section VIII, Division 1; bearing appropriate code symbols.
 - 1. Interior Finish: Corrosion-resistant coating.
 - 2. Accessories: Include vacuum relief valve, vacuum gage, and drain.

2.2 OIL-FREE, DRY CLAW VACUUM PUMPS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Amico Corporation.
 - 2. BeaconMedaes.
- B. Description: Packaged unit.
- C. Vacuum Pump(s): Nonpulsating, oil-free, rotary, sliding-vane type.
 - 1. Cleanable inlet screens.
 - 2. Outlet silencers on discharge connections.

2.3 MEDICAL VACUUM EQUIPMENT ALARM SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Allied Healthcare Products, Inc.; Chemetron Div.
 - 2. Amico Corporation.
 - 3. BeaconMedaes.
- B. General Requirements for Medical Vacuum Equipment Alarm System: Compatible alarm panels, remote sensing devices, and other related components as required by NFPA 99 for Level 1 alarm systems. Refer to Division 22 Section "Vacuum Piping for Laboratory and Healthcare Facilities" for medical vacuum piping and alarm systems. Power wiring is specified in Division 26 Sections.
- C. Components: Designed for continuous service and to operate on power supplied from 277-V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.
- D. Vacuum Switches or Transducer Sensors: Continuous equipment monitoring with electrical connections for alarm system.
 - 1. Vacuum Switches: 0- to 30-in. Hg vacuum operating range.
- E. General Requirements for Medical Vacuum Equipment Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.
 - 1. Mounting: Recessed installation.
 - 2. Enclosures: Fabricated from minimum 0.047-inch- thick steel or minimum 0.05-inchthick aluminum, with knockouts for electrical and piping connections.
- F. Local and Master Alarm Panels: Separate trouble alarm signals and pressure gages to indicate function of medical vacuum equipment when the following conditions exist:
 - 1. Medical Vacuum Equipment: Drops below 12-in. Hg vacuum, backup vacuum producer is in operation, and high water level is in receiver.
 - 2. WAGD Evacuation Equipment: Drops below 12-in. Hg vacuum, backup vacuum producer is in operation, and high water level is in receiver.

2.4 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 22 Section "Common Motor Requirements for Plumbing Equipment."
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

PART 3 - EXECUTION

3.1 **PREPARATION**

A. Clean vacuum equipment, accessories, and components that have not been cleaned for oxygen service and sealed or that are furnished unsuitable for laboratory vacuum and medical vacuum applications, according to CGA G4.1, "Cleaning Equipment for Oxygen Service."

3.2 VACUUM EQUIPMENT INSTALLATION

- A. Install vacuum equipment for healthcare facilities according to ASSE 6010 and NFPA 99.
- B. Equipment Mounting: Install vacuum producers on concrete bases using elastomeric pads. Comply with requirements in Division 03 Section "Miscellaneous Cast-in-Place Concrete." Comply with requirements for vibration isolation devices specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
 - 1. Minimum Deflection: 1/4 inch.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 - 3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
- C. Install vacuum equipment anchored to substrate.
- D. Orient equipment so controls and devices are accessible for servicing.
- E. Maintain manufacturer's recommended clearances for service and maintenance.
- F. Install the following devices on vacuum equipment:
 - 1. Thermometer, Vacuum Gage, and Pressure Relief Valve: Install on each vacuum pump receiver.

2. Drain Valves: Install on receivers and separators. Discharge receiver condensate over nearest floor drain. Discharge separator oral evacuation fluids by direct connection into sanitary waste piping system.

3.3 MEDICAL VACUUM EQUIPMENT ALARM SYSTEM INSTALLATION

- A. Alarm panels for medical vacuum equipment may be combined in single panels with medical air equipment and medical gas piping systems.
- B. Install medical vacuum equipment alarm system components in locations required by and according to NFPA 99.
- C. Install medical vacuum equipment local and master alarm panels where indicated.

3.4 CONNECTIONS

- A. Comply with requirements for water-supply piping specified in Division 22 Section "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Comply with requirements for drain piping specified in Division 22 Section "Sanitary Waste and Vent Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- C. Comply with requirements for vacuum piping specified in Division 22 Section "Vacuum Piping for Laboratory and Healthcare Facilities." Drawings indicate general arrangement of piping, fittings, and specialties.
- D. Install piping adjacent to equipment to allow service and maintenance.
- E. Connect vacuum piping to vacuum equipment, accessories, and specialties with shutoff valve and union or flanged connection.
- F. Connect water supply to vacuum equipment that requires water. Include backflow preventer. Backflow preventers are specified in Division 22 Section "Domestic Water Piping Specialties."

3.5 IDENTIFICATION

A. Identify medical vacuum equipment system components. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment." and with NFPA 99.

3.6 FIELD QUALITY CONTROL FOR HEALTHCARE-FACILITY MEDICAL VACUUM EQUIPMENT

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

- D. Tests and Inspections:
 - 1. Medical Vacuum Equipment Testing Coordination: Perform tests, inspections, verifications, and certification of medical vacuum equipment concurrently with tests, inspections, and certification of medical compressed-air equipment, medical compressed-air piping, medical vacuum piping, and medical gas piping systems.
 - 2. Preparation: Perform medical vacuum equipment tests according to requirements in NFPA 99 for the following:
 - a. System operation test.
 - 3. Equipment Verification: Comply with requirements in ASSE 6020, ASSE 6030, and NFPA 99 for verification of medical vacuum equipment.
 - 4. Replace damaged and malfunctioning controls and equipment.
 - 5. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
 - a. Inspections performed.
 - b. Procedures and materials used.
 - c. Test methods used.
 - d. Results of tests.
- E. Components will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports.

3.7 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Check for lubricating oil in lubricated-type equipment.
 - 3. Check belt drives for proper tension.
 - 4. Verify that vacuum producer outlet piping is clear.
 - 5. Check for equipment vibration-control supports and flexible pipe connectors and verify that equipment is properly attached to substrate.
 - 6. Check safety valves for correct settings.
 - 7. Drain receiver and separator tank(s).
 - 8. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 9. Test and adjust controls and safeties.
- B. Verify that vacuum equipment is installed and connected according to the Contract Documents.
- C. Verify that electrical wiring installation complies with manufacturer's submittal and written installation requirements in Division 26 Sections.
- D. Prepare written report documenting testing procedures and results.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain vacuum producers.

END OF SECTION 22 6219

SECTION 22 6313 GAS PIPING FOR HEALTHCARE FACILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

- 1. Carbon dioxide piping and specialties designated "medical carbon dioxide" operating at 50 to 55 psig. Coordinate required pressure with equipment served and provide higher pressure manifold if required.
- 2. Nitrogen piping and specialties designated "medical nitrogen" operating at 160 to 185 psig.
- 3. Nitrous oxide piping and specialties designated "medical nitrous oxide" operating at 50 to 55 psig.
- 4. Oxygen piping and specialties designated "medical oxygen" operating at 50 to 55 psig.

1.3 DEFINITIONS

- A. CR: Chlorosulfonated polyethylene synthetic rubber.
- B. D.I.S.S.: Diameter-index safety system.
- C. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- D. Medical gas piping systems include medical carbon dioxide, medical nitrogen, medical nitrous oxide and medical oxygen nonflammable gas for healthcare facility patient care or for healthcare laboratory applications.
- E. Specialty Gas: Gas, other than medical gas, for nonmedical laboratory facility applications.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Tubes and fittings.
 - 2. Valves and valve boxes.
 - 3. Medical gas service connections.
 - 4. Patient service consoles.
 - 5. Medical nitrogen pressure control panels.
 - 6. Ceiling columns. Include integral service connections.
 - 7. Ceiling hose assemblies. Include integral service connections.
 - 8. Medical gas alarm system components.
- B. Shop Drawings: Diagram power, signal, and control wiring.

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 121505 Gas Piping for Healthcare Facilities Section 22 6313 - 1

- C. Piping Material Certification: Signed by Installer certifying that medical gas piping materials comply with NFPA 99 requirements.
- D. Qualification Data: For Installer and testing agency.
- E. Brazing certificates.
- F. Field quality-control test reports.
- G. Operation and Maintenance Data: For specialty and medical gas piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Medical Gas Piping Systems for Healthcare Facilities: Qualify installers according to ASSE Standard #6010 for installers.
- B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the medical gas piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Qualify testing personnel according to ASSE Standard #6020 for inspectors and ASSE Standard #6030 for verifiers.
- C. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications"; or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. NFPA Compliance:
 - 1. Comply with NFPA 99, "Health Care Facilities," for medical gas piping system materials and installation.
- F. UL Compliance:
 - 1. Comply with UL 544, "Medical and Dental Equipment," for medical gas specialties.

1.6 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate medical gas service connections with other service connections. Medical-air service connections are specified in Division 22 Sections "Medical-Air Piping for Laboratory and Healthcare Facilities" and "Vacuum Piping for Laboratory and Healthcare Facilities."

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

- Copper Medical Gas Tube: ASTM B 819, Type L, seamless, drawn temper that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED,"
 "OXY/MED," "OXY/ACR," or "ACR/MED" in green for Type K tube and blue for Type L tube.
 - 1. General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.
 - 2. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, with dimensions for brazed joints.
 - 3. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.

2.2 JOINING MATERIALS

A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys.

2.3 VALVES

- A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.
- B. Ball Valves: MSS SP-110, 3-piece body, brass or bronze.
 - 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:

a. Amico Corporation. b. BeaconMedaes.

- 2. Pressure Rating: 300 psig minimum.
- 3. Ball: Full-port, chrome-plated brass.
- 4. Seats: PTFE or TFE.
- 5. Handle: Lever type with locking device.
- 6. Stem: Blowout proof with PTFE or TFE seal.
- 7. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
- C. Check Valves: In-line pattern, bronze.
 - 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - a. Amico Corporation.
 - b. BeaconMedaes.
 - 2. Pressure Rating: 300 psig minimum.
 - 3. Operation: Spring loaded.
 - 4. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
- D. Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.

- 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - a. Amico Corporation.
 - b. BeaconMedaes.
- 2. Pressure Rating: 300 psig minimum.
- 3. Ball: Full-port, chrome-plated brass.
- 4. Seats: PTFE or TFE.
- 5. Handle: Lever type with locking device.
- 6. Stem: Blowout proof with PTFE or TFE seal.
- 7. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
- 8. Pressure Gage: Manufacturer-installed on one copper-tube extension.
- E. Zone Valve Boxes: Formed steel with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gages and in sizes required to permit manual operation of valves.
 - 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - a. Amico Corporation.
 - b. BeaconMedaes.
 - 2. Interior Finish: Factory-applied white enamel.
 - 3. Cover Plate: Satin-chrome finish steel with frangible or removable windows.
 - 4. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.
- F. Safety Valves: Bronze-body, ASME-construction, poppet, pressure-relief type with settings to match system requirements.
- G. Pressure Regulators: Bronze body and trim; spring-loaded, diaphragm-operated, relieving type; manual pressure-setting adjustment; rated for 250-psig minimum inlet pressure; and capable of controlling delivered gas pressure within 0.5 psig for each 10-psig inlet pressure.

2.4 MEDICAL GAS SERVICE CONNECTIONS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - 1. Amico Corporation.
 - 2. BeaconMedaes.
- B. General Requirements for Medical Gas Service Connections,: For specific medical gas pressure and suction service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.
 - 1. Roughing-in Assembly:
 - a. Steel outlet box for recessed mounting and concealed piping.

- b. Brass-body outlet block with secondary check valve that will prevent gas flow when primary valve is removed. Suction inlets to be without secondary valve.
- c. Double seals that will prevent gas leakage.
- d. ASTM B 819, NPS 3/8 copper outlet tube brazed to valve with service marking and tube-end dust cap.
- 2. Finishing Assembly:
 - a. Brass housing with primary check valve.
 - b. Double seals that will prevent gas leakage.
 - c. Cover plate with gas-service label.
- 3. Quick-Coupler Service Connections: Pressure outlets for carbon dioxide, nitrous oxide and oxygen service connections with non-interchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.
- 4. D.I.S.S. Service Connections: Pressure outlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.
 - a. Medical Carbon Dioxide Service Connections: D.I.S.S. No. 1080.
 - b. Medical Nitrogen Service Connections: D.I.S.S. No. 1120.
 - c. Medical Nitrous Oxide Service Connections: D.I.S.S. No. 1040.
 - d. Medical Oxygen Service Connections: D.I.S.S. No. 1240.
- 5. Cover Plates: One-piece, stainless steel, with NAAMM AMP 503, No. 4 finish and permanent, color-coded, identifying label matching corresponding service.

2.5 MEDICAL NITROGEN PRESSURE CONTROL PANELS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - 1. Amico Corporation.
 - 2. BeaconMedaes.
- B. Description: Steel box and support brackets for recessed roughing-in with stainless-steel or anodized-aluminum cover plate with printed operating instructions. Include manifold assembly consisting of inlet supply valve, inlet supply pressure gage, line-pressure control regulator, outlet supply pressure gage, D.I.S.S. service connection, and piping outlet for remote service connection.
 - 1. Minimum Working Pressure: 200 psig.
 - 2. Line-Pressure Control Regulator: Self-relieving diaphragm type with precision manual adjustment.
 - 3. Pressure Gages: 0- to 300-psig range.
 - 4. Service Connection: CGA V-5, D.I.S.S. No. 1120, nitrogen outlet.
 - 5. Before final assembly, provide temporary dust shield and U-tube for testing.
 - 6. Label cover plate "Nitrogen Pressure Control."

2.6 MEDICAL GAS PIPING ALARM SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - 1. Amico Corporation.
 - 2. BeaconMedaes.
- B. Panels for medical gas piping systems may be combined in single panels with medical compressed-air and medical vacuum piping systems.
- C. Components: Designed for continuous service and to operate on power supplied from 120V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.
- D. Pressure Switches or Pressure Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
 - 1. Low-Pressure Operating Range: 0- to 100-psig.
 - 2. High-Pressure Operating Range: Up to 250-psig.
- E. General Requirements for Medical Gas Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.
 - 1. Mounting: Recessed installation.
 - 2. Enclosures: Fabricated from minimum 0.047-inch- thick steel or minimum 0.05inch- thick aluminum, with knockouts for electrical and piping connections.
- F. Anesthetizing-Area Alarm Panels: Separate trouble alarm signals; pressure gages; and indicators for medical gas piping systems.
 - 1. Include alarm signals when the following conditions exist:
 - a. Medical Carbon Dioxide: Pressure drops below 40 psig or rises above 60 psig.
 - b. Medical Nitrous Oxide: Pressure drops below 40 psig or rises above 60 psig.
 - c. Medical Nitrogen: Pressure drops below 145 psig or rises above 200 psig.
 - d. Medical Oxygen: Pressure drops below 40 psig or rises above 60 psig.
- G. Area Alarm Panels: Separate trouble alarm signals; pressure and vacuum gages; and indicators for medical gas piping systems.
 - 1. Include alarm signals when the following conditions exist:
 - a. Oxygen: Pressure drops below 40 psig or rises above 60 psig.
- H. Medical Laboratory Area Alarm Panels: Separate trouble alarm signals; pressure and vacuum gages; and indicators for medical gas piping systems.
 - 1. Include alarm signals when the following conditions exist:
 - a. Medical Carbon Dioxide: Pressure drops below 40 psig or rises above 60 psig.
 - b. Medical Oxygen: Pressure drops below 40 psig or rises above 60 psig.

2.7 BUILDING CONTROL SYSTEM INTERFACE

- A. Description: Wall-mounting, welded-steel, control cabinet with gasketed door, mounting brackets, grounding device, and white-enamel finish for connection of medical gas system alarms to facility computer. Include factory-installed signal circuit boards, power transformer, circuit breaker, wiring terminal board, and internal wiring capable of interfacing 20 alarm signals.
- B. For each remote alarm provided at the alarm annunciator panel, provide a set of Form C dry contacts for remote monitoring at the Building Control System provided under Section 23 0900 "Building Control System".
- C. In lieu of the dry contacts required in Paragraph A above, the manufacturer shall have the option of furnishing one of the following communications network interfaces to the Building Control System:
 - 1. An industry standard open protocol communications network interface fully compatible with and interconnecting with the Building Control System communications network, based on one of the following network communications protocols:
 - BACNet TCP/IP- network communications shall use ASHRAE 135 protocol and communicate using ISO 802-3 (Ethernet) datalink/physical layer protocol;
 - BACNet MS/TP network communications shall use ASHRAE 135 read (execute and initiate) and write (execute and initiate) property services defined in ASHRAE 135, residing on network using MS/TP datalink/physical layer protocol and have service communication port for connection to the BCS; or,
 - c. ModBus/TP network communications shall use ModBus/TP over TCP/IP network.
 - 2. Communications network hardware and firmware to allow communications with an IP address communicating directly over the Facility local area network complying with ISO 802-3 (Ethernet).

2.8 ESCUTCHEONS

- A. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to closely fit around pipe and tube and OD that completely covers opening.
- B. One-Piece, Cast-Brass Escutcheons: With set screw.
 - 1. Finish: Polished chrome-plated.

2.9 NITROGEN

A. Description: Comply with USP 28 - NF 23 for oil-free dry nitrogen.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing are not available or if precleaned fittings or tubing must be recleaned because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction, perform the following procedures:
 - 1. Clean medical gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1, "Cleaning Equipment for Oxygen Service."
 - 2. Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb of chemical to 3 gal. of water.
 - a. Scrub to ensure complete cleaning.
 - b. Rinse with clean, hot water to remove cleaning solution.

3.2 EARTHWORK

A. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling and for underground warning tapes.

3.3 PIPING APPLICATIONS

- A. Medical Gas Piping: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
- B. Medical Nitrogen Piping: Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.

3.4 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of gas piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Comply with ASSE Standard #6010 for installation of medical gas piping.
- C. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
- F. Install piping adjacent to equipment and specialties to allow service and maintenance.

- G. Install nipples, unions, and special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications below unless otherwise indicated.
- H. Install piping to permit valve servicing.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Install medical gas piping to medical gas service connections specified in this Section, to medical gas service connections in equipment specified in this Section, and to equipment specified in other Sections requiring medical gas service.
- L. Install exterior, buried medical gas piping in protective conduit fabricated with PVC pipe and fittings. Do not extend conduit through foundation wall.
- M. Install medical gas service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.
- N. Connect gas piping to gas sources and to gas outlets and equipment requiring gas service.
- O. Install unions, in copper tubing adjacent to each valve and at final connection to each piece of equipment and specialty.

3.5 VALVE INSTALLATION

- A. Install shutoff valve at each connection to gas laboratory and healthcare equipment and specialties.
- B. Install check valves to maintain correct direction of gas flow from laboratory and healthcare gas supplies.
- C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.
- D. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.
- E. Install pressure regulators on gas piping where reduced pressure is required.
- F. Install emergency oxygen connection with pressure relief valve and full-size discharge piping to outside, with check valve downstream from pressure relief valve and with ball valve and check valve in supply main from bulk oxygen storage tank.

3.6 JOINT CONSTRUCTION

- A. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
- B. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter. Continuously purge joint with oil-free, dry nitrogen during brazing.

3.7 GAS SERVICE COMPONENT INSTALLATION

- A. Assemble patient service console with service connections. Install with supplies concealed, in walls. Attach console box or mounting bracket to substrate.
- B. Install nitrogen pressure-control panels in walls. Attach to substrate.
- C. Assemble ceiling columns and install anchored to substrate. Provide structural steel, hanger rods, anchors, and fasteners in addition to components furnished with specialties necessary to fabricate supports.
- D. Assemble ceiling assemblies and install anchored to substrate. Provide structural steel, hanger rods, anchors, and fasteners in addition to components furnished with specialties necessary to fabricate supports.
- E. Install gas manifolds on concrete base anchored to substrate.
- F. Install gas cylinders and connect to manifold piping.

3.8 MEDICAL GAS PIPING ALARM SYSTEM INSTALLATION

- A. Install medical gas alarm system components in locations required by and according to NFPA 99.
- B. Install medical gas area and master alarm panels where indicated.
- C. Install computer interface cabinet with connection to medical gas piping alarm system and facility computer.

3.9 ESCUTCHEON INSTALLATION

- A. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. New Piping:
 - a. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
 - b. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.

3.10 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.
- B. Vertical Piping: MSS Type 8 or 42, clamps.
- C. Individual, Straight, Horizontal Piping Runs:
 - 1. 100 Feet and Less: MSS Type 1, adjustable, steel, clevis hangers.
 - 2. Longer than 100 Feet: MSS Type 43, adjustable, roller hangers.

- D. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for trapeze hangers.
- E. Base of Vertical Piping: MSS Type 52, spring hangers.
- F. Support horizontal piping within 12 inches of each fitting and coupling.
- G. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- H. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1/4: 60 inches with 3/8-inch rod.
 - 2. NPS 3/8 and NPS 1/2: 72 inches with 3/8-inch rod.
 - 3. NPS 3/4: 84 inches with 3/8-inch rod.
 - 4. NPS 1: 96 inches with 3/8-inch rod.
 - 5. NPS 1-1/4: 108 inches with 3/8-inch rod.
 - 6. NPS 1-1/2: 10 feet with 3/8-inch rod.
 - 7. NPS 2: 11 feet with 3/8-inch rod.
 - 8. NPS 2-1/2: 13 feet with 1/2-inch rod.
 - 9. NPS 3: 14 feet with 1/2-inch rod.
 - 10. NPS 3-1/2: 15 feet with 1/2-inch rod.
 - 11. NPS 4: 16 feet with 1/2-inch rod.
 - 12. NPS 5: 18 feet with 1/2-inch rod.
 - 13. NPS 6: 20 feet with 5/8-inch rod.
 - 14. NPS 8: 23 feet with 3/4-inch rod.
- I. Install supports for vertical copper tubing every 10 feet.

3.11 LABELING AND IDENTIFICATION

- A. Install identifying labels and devices for specialty gas piping, valves, and specialties. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment."
- B. Install identifying labels and devices for healthcare medical gas piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:
 - 1. Carbon Dioxide: Black or white letters on gray background.
 - 2. Nitrogen: White letters on black background.
 - 3. Nitrous Oxide: White letters on blue background.
 - 4. Oxygen: White letters on green background or green letters on white background.

3.12 FIELD QUALITY CONTROL FOR LABORATORY FACILITY SPECIALTY GAS

- A. Testing Agency: Engage qualified testing agency to perform field tests and inspections of specialty gas piping for non-healthcare laboratory facilities and prepare test reports.
- B. Tests and Inspections:

- 1. Piping Leak Tests for Specialty Gas Piping: Test new and modified parts of existing piping. Cap and fill specialty gas piping with oil-free, dry nitrogen to pressure of 50 psig above system operating pressure, but not less than 150 psig. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
- 2. Repair leaks and retest until no leaks exist.
- 3. Inspect specialty gas regulators for proper operation.

3.13 FIELD QUALITY CONTROL FOR HEALTHCARE FACILITY MEDICAL GAS

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections of medical gas piping systems in healthcare facilities and prepare test reports.
- B. Tests and Inspections:
 - 1. Medical Gas Piping Testing Coordination: Perform tests, inspections, verifications, and certification of medical gas piping systems concurrently with tests, inspections, and certification of medical compressed-air piping andmedical vacuum piping systems.
 - 2. Preparation: Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:
 - a. Initial blow down.
 - b. Initial pressure test.
 - c. Cross-connection test.
 - d. Piping purge test.
 - e. Standing pressure test for positive pressure medical gas piping.
 - f. Standing pressure test for vacuum systems.
 - g. Repair leaks and retest until no leaks exist.
 - 3. System Verification: Comply with requirements in NFPA 99, ASSE Standard #6020, and ASSE Standard #6030 for verification of medical gas piping systems and perform the following tests and inspections:
 - a. Standing pressure test.
 - b. Individual-pressurization or pressure-differential cross-connection test.
 - c. Valve test.
 - d. Master and area alarm tests.
 - e. Piping purge test.
 - f. Piping particulate test.
 - g. Piping purity test.
 - h. Final tie-in test.
 - i. Operational pressure test.
 - j. Medical gas concentration test.
 - k. Medical air purity test.
 - I. Verify correct labeling of equipment and components.
 - m. Verify the following source equipment:
 - 1) Medical gas supply sources.
 - 4. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:

- Inspections performed. a.
- Procedures, materials, and gases used. Test methods used. b.
- c.
- Results of tests. d.
- C. Remove and replace components that do not pass tests and inspections and retest as specified above.

END OF DOCUMENT 22 6313

SECTION 22 6411.1 FACILITY FUEL OIL PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes diesel-fuel-oil distribution systems and the following:
 - 1. Pipes, tubes, and fittings.
 - 2. Piping and tubing joining materials.
 - 3. Piping specialties.
 - 4. Valves.
 - 5. Fuel-oil USTs.
 - 6. Fuel-oil UST accessories.
 - 7. Fuel-oil storage tank piping specialties.
 - 8. Liquid-level gage system.
 - 9. Leak-detection and monitoring system.
 - 10. Mechanical sleeve seals.

1.03 DEFINITIONS

- A. UST: Underground storage tank
- B. AST: Aboveground storage tank.
- C. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- D. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- E. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- F. FPM: Vinylidene fluoride-hexafluoropropylene copolymer rubber.
- G. FRP: Glass-fiber-reinforced plastic.

1.04 PERFORMANCE REQUIREMENTS

A. Maximum Operating-Pressure Ratings: Where applicable, 3-psig fuel-oil supply pressure at oil-fired appliances.

1.05 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, and dimensions of individual components and profiles. Also include, where applicable, rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 1. Piping specialties.

- 2. Valves: Include pressure rating, capacity, settings, and electrical connection data of selected models.
- 3. Each type and size of fuel-oil storage tank. Indicate storage capacity, dimensions, weights, loads, components, and location and size of each field connection.
- 4. Manufacturer installation guidelines specific for the project.
- 5. Fuel-oil storage tank accessories.
- 6. Fuel-oil storage tank piping specialties.
- 7. Liquid-level gage system.
- 8. Leak-detection and monitoring system.
- B. Shop Drawings: For facility fuel-oil piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
 - 1. Shop Drawing Scale: 1/8 inch per foot.
 - 2. For fuel-oil storage tanks and pumps, include details of supports and anchors.
- C. Coordination Drawings: Plans and details, drawn to scale, on which fuel-oil piping is shown and coordinated with other installations, using input from installers of the items involved.
- D. Welding certificates.
- E. Field quality-control reports.
- F. Operation and Maintenance Data: For fuel-oil equipment and accessories to include in emergency, operation, and maintenance manuals.
- G. Warranty: Sample of special warranty.

1.06 QUALITY ASSURANCE

- A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with ASME B31.9, "Building Services Piping," for fuel-oil piping materials, installation, testing, and inspecting.
- E. Comply with requirements of the EPA and of state and local authorities having jurisdiction. Include recording of fuel-oil storage tanks and monitoring of tanks and piping.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Lift and support fuel-oil storage tanks only at designated lifting or supporting points, as shown on Shop Drawings. Do not move or lift tanks unless empty.
- B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
1.08 PROJECT CONDITIONS

- A. Interruption of Existing Fuel-Oil Service: Do not interrupt fuel-oil service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary fuel-oil supply according to requirements indicated:
 - 1. Notify Owner no fewer than three days in advance of proposed interruption of fueloil service.
 - 2. Do not proceed with interruption of fuel-oil service without Owner's written permission.

1.09 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace double-containment piping and related equipment that fail in materials or workmanship within specified warranty period.
 - 1. Storage Tanks:
 - a. Failures include, but are not limited to, the following when used for storage of fuel oil at temperatures not exceeding 150 deg F:
 - 1) Structural failures including cracking, breakup, and collapse.
 - 2) Corrosion failure including external and internal corrosion of steel tanks.
 - 2. Double-Containment Piping and Related Equipment:
 - a. Failures due to defective materials or workmanship for materials installed together, including piping, dispenser sumps, entry boots, and sump mounting adapters.
 - b. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PIPES, TUBES, AND FITTINGS

- A. See Part 3 piping schedule articles for where pipes, tubes, fittings, and joining materials are applied in various services.
- B. Steel Pipe Aboveground (Pipes inside building trench and exposed): Aboveground, ASTM A 53, black steel, Schedule 40, Type E or S, Grade B, seamless or ERW.
 - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
 - 2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M, for butt and socket welding.
 - 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.

2.02 DOUBLE-CONTAINMENT PIPE AND FITTINGS (Underground Pipe sections)

- A. Rigid, Double-Containment Piping: Comply with UL 971.
 - 1. Piping system shall be FDEP-approved and listed with EQ#825.

- 2. The secondary containment piping system manufacturer shall supply a complete design submittal, including layout drawings, catalog sheets, material data and pipe stress and end load calculations in accordance with ANSI B31.3 latest edition. The calculations shall be stamped by a Registered Professional Engineer.
- 3. Carrier pipe shall be standard weight carbon steel, ASTM A-53, Grade B, ERW or seamless. All joints shall be butt welded for sizes 2-1/2 inches and greater, and socket or butt welded for 2 inches and below. Where possible, straight sections shall be supplied in 40 foot random lengths, with 4 inches of piping exposed at each end for field joint fabrication.
- 4. The secondary containment shall be a fabricated out of standard weight, carbon steel, in accordance with ASTM A-135 Grade B or ASTM A-53 Grade B, with a FRP jacket for corrosion protection
- 5. The carbon steel containment pipe shall be furnished from the system manufacturer with red mill primer. Field joints shall cleaned and re-primed by the installing contractor. All installed piping shall be finish painted by the contractor and identified with decals as may be required by the local AHJ.
- 6. Carrier pipe supports, within the secondary containment pipe, shall be carbon steel.250" thick plate and shall be designed and factory installed by the secondary containment piping system manufacturer. Support spacing shall be determined by the manufacturer based on pipe diameter, pipe material and operating temperature of the product pipes. In all cases, pipes within the secondary containment shall be supported at not more than 10 foot intervals. These supports shall be designed to allow for continuous air-flow and drainage of the secondary containment in place. No plastic supports will be allowed.
- 7. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Perma-Pipe Ultra FS (Factory Rep. Hurtado.CC (386) 690-6361)

2.03 PIPING SPECIALTIES

- A. Flexible Connectors: Comply with UL 567, approved for fuel oil service.
 - 1. Metallic Connectors:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) American Flexible Hose Co., Inc.
 - 2) Flexicraft Industries.
 - 3) FLEX-ING, Inc.
 - 4) Metraflex Company (The).
 - 5) Proco Products, Inc.
 - b. Listed and labeled for aboveground and underground applications by an NRTL acceptable to authorities having jurisdiction.
 - c. Stainless-steel bellows with woven, flexible, bronze or stainless-steel, wirereinforcing protective jacket.
 - d. Minimum Operating Pressure: 150 psig.
 - e. End Connections: Socket, flanged, or threaded end to match connected piping.
 - f. Maximum Length: 30 inches

- g. Swivel end, 50-psig maximum operating pressure.
- h. Factory-furnished anode.
- 2. Nonmetallic Connectors, approved for fuel oil service:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) American Flexible Hose Co., Inc.
 - 2) Flexicraft Industries.
 - 3) FLEX-ING, Inc.
 - 4) Metraflex Company (The).
 - 5) Tru-Flex Metal Hose Corp.
 - b. Listed and labeled for underground applications by an NRTL acceptable to authorities having jurisdiction.
 - c. PFTE bellows with woven, flexible, bronze or stainless-steel, wirereinforcing protective jacket.
 - d. Minimum Operating Pressure: 150 psig.
 - e. End Connections: Socket, flanged, or threaded end to match connected piping.
 - f. Maximum Length: 30 inches
 - g. Swivel end, 50-psig maximum operating pressure.
 - h. Factory-furnished anode.
- B. Y-Pattern Strainers:
 - 1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
 - 2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
 - 3. Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
 - 4. CWP Rating: 125 psig.
- C. Manual Air Vents:
 - 1. Body: Bronze.
 - 2. Internal Parts: Nonferrous.
 - 3. Operator: Screwdriver or thumbscrew.
 - 4. Inlet Connection: NPS 1/2.
 - 5. Discharge Connection: NPS 1/8.
 - 6. CWP Rating: 150 psig.
 - 7. Maximum Operating Temperature: 225 deg F.

2.04 JOINING MATERIALS

- A. Joint Compound and Tape: Suitable for fuel oil.
- B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

C. Bonding Adhesive for Fiberglass Piping: As recommended by fiberglass piping manufacturer.

2.05 MANUAL FUEL-OIL SHUTOFF VALVES

- A. See valve schedule in Part 3 for where each valve type is applied in various services.
- B. General Requirements for Metallic Valves, NPS 2 and Smaller for Liquid Service: Comply with UL 842.
 - 1. CWP Rating: 125 psig.
 - 2. Threaded Ends: Comply with ASME B1.20.1.
 - 3. Tamperproof Feature: Locking feature for valves indicated in the valve schedule.
 - 4. Service Mark: Initials "WOG" shall be permanently marked on valve body.
- C. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with UL 842.
 - 1. CWP Rating: 125 psig.
 - 2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
 - 3. Tamperproof Feature: Locking feature for valves indicated in the valve schedule.
 - 4. Service Mark: Initials "WOG" shall be permanently marked on valve body.
- D. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following suitable for fuel oil:
 - 2. BrassCraft Manufacturing Company; a Masco company.
 - 3. Conbraco Industries, Inc.; Apollo Div.
 - 4. Body: Bronze, complying with ASTM B 584.
 - 5. Ball: Chrome-plated bronze.
 - 6. Stem: Bronze; blowout proof.
 - 7. Seats: Reinforced TFE; blowout proof.
 - 8. Packing: Threaded-body packnut design with adjustable-stem packing.
 - 9. Ends: Threaded, flared, or socket as indicated in the valve schedule.
 - 10. CWP Rating: 600 psig.
 - 11. Service Mark: Initials "WOG" shall be permanently marked on valve body.

2.06 SPECIALTY VALVES

- A. Pressure Relief Valves: Comply with UL 842. This section also includes the requirement for thermal expansion pressure relief valves, where required to allow fuel pressure relief due to thermal expansion in closed pipe sections.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anderson Greenwood; Division of Tyco Flow Control.
 - b. Fulflo Specialties, Inc.
 - c. Webster Fuel Pumps & Valves; a division of Capital City Tool, Inc.
 - 2. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.

- 3. Body: Brass, bronze, or cast steel.
- 4. Springs: Stainless steel, interchangeable.
- 5. Seat and Seal: Nitrile rubber.
- 6. Orifice: Stainless steel, interchangeable.
- 7. Factory-Applied Finish: Baked enamel.
- 8. Maximum Inlet Pressure: 150 psig.
- 9. Relief Pressure Setting: 90 psig.
- B. Oil Safety Valves: Comply with UL 842.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anderson Greenwood; Division of Tyco Flow Control.
 - b. Suntec Industries Incorporated.
 - c. Webster Fuel Pumps & Valves; a division of Capital City Tool, Inc.
 - 2. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.
 - 3. Body: Brass, bronze, or cast steel.
 - 4. Springs: Stainless steel.
 - 5. Seat and Diaphragm: Nitrile rubber.
 - 6. Orifice: Stainless steel, interchangeable.
 - 7. Factory-Applied Finish: Baked enamel.
 - 8. Manual override port.
 - 9. Maximum Inlet Pressure: Coordinate with manufacturer.
 - 10. Maximum Outlet Pressure: Coordinate with manufacturer.
- C. Emergency Shutoff Valves (where required): Comply with UL 842.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. OPW
 - b. Ameron International; Fiberglass Pipe Group.
 - c. Conley Corporation.
 - d. EMCO Wheaton; a Gardner Denver Company.
 - 2. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.
 - 3. Single poppet valve.
 - 4. Body: ASTM A 126, cast iron.
 - 5. Disk: FPM.
 - 6. Poppet Spring: Stainless steel.
 - 7. Stem: Plated brass.
 - 8. O-Ring: FPM.

Project No. 121505 Facility Fuel-Oil Piping Section 22 6411.1 - 7

- 9. Packing Nut: PTFE-coated brass.
- 10. Fusible link to close valve at 165 deg F.
- 11. Thermal relief to vent line pressure buildup due to fire.
- 12. Air test port.
- 13. Maximum Operating Pressure: 0.5 psig.
- D. Mechanical Leak Detector (where required): Comply with UL 842.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Veeder Root
 - b. Simplex.
 - c. Pneumercator Inc.
 - 2. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.
 - 3. Body: ASTM A 126, cast iron.
 - 4. O-Rings: Elastomeric compatible with fuel oil.
 - 5. Piston and Stem Seals: PTFE.
 - 6. Stem and Spring: Stainless steel.
 - 7. Piston Cylinder: Burnished brass.
 - 8. Indicated Leak Rate: Maximum 3 gph at 10 psig.
 - 9. Leak Indication: Reduced flow.

2.07 FUEL-OIL UST

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Basis of Design: General Industries: Permatank Double Wall Jacketed
 - 2. Modern Welding Glasteel II
 - 3. Xerxes Corporation.
- B. Description: Horizontal, UST; Inner steel tank with an exterior corrosion resistant FRP tank, UL 1746, UL 58, double wall, with interstitial space and integral, hydrostatic, leak-detection and monitoring system.
- C. Construction: Inner steel tank with an exterior corrosion resistant FRP tank; suitable for operation at atmospheric pressure; fabricated for the following loads:
 - 1. Depth of Bury: 3-5 feet from top of tank to finished surface.
 - 2. External Hydrostatic Pressure: To withstand general buckling with safety factor of 2:1 if hole is fully flooded.
 - 3. Surface Loads: AASHTO's "Specifications for Highway Bridges," H-20 axle loads of 32,000 lb.
- D. Capacities and Characteristics:
 - 1. Capacity: see drawings.
 - 2. Diameter: by manufacturer.

- 3. Length: by manufacturer.
- 4. Connection Sizes: (see drawings for minimum connections)
- 5. Manholes:
 - a. Number Required: see drawings
 - b. Diameter: see drawings
- 6. Fuel-Oil Grade Number: Number 2.

2.08 FUEL OIL UST ACCESSORIES

- A. Tank Manholes: 24-inch-minimum diameter; bolted, flanged, and gasketed, with extension collar; for access to inside of tank/pumps.
- B. Threaded pipe connection fittings on top of tank for fill, supply, return, vent, sounding, polishing and gaging, in locations and of sizes indicated. Include cast-iron plugs for shipping.
- C. Striker Plates: Inside tank, on bottom below fill, vent, sounding, gage, and other tube openings.
- D. Lifting Lugs: For handling and installation.
- E. Supply Tube: Extension of supply piping fitting into tank, terminating 6 inches above tank bottom and cut at a 45-degree angle.
- F. Sounding and Gage Tubes: Extension of fitting into tank, terminating 6 inches above tank bottom and cut at a 45-degree angle.
- G. Containment Sumps: Fiberglass with sump base, add-on extension pieces as required, sump top, lid, and gasket-seal joints. Include sump entry boots for pipe penetrations through sidewalls.
- H. Sump Entry Boots: Two-part pipe fitting for field assembly and of size required to fit over pipe. Include gaskets shaped to fit sump sidewall, sleeves, seals, and clamps as required for liquid-tight pipe penetrations.
- I. Anchor Straps: Storage tank manufacturer's standard anchoring system, with straps, strap-insulating material, cables and turnbuckles, of strength at least one and one-half times maximum uplift force of empty tank without backfill in place.
- J. Filter Mat: Geotextile woven or spun filter fabric, in 1 or more layers, for minimum total weight of 3 oz./sq. yd.
- K. Overfill Prevention Valves: Factory fabricated or field assembled from manufacturer's standard components. Include drop tube, cap, fill nozzle adaptor, check valve mechanism or other devices, and vent if required to restrict flow at 95 percent of tank capacity and to provide complete shutoff of filling at 98 percent of tank capacity.

2.09 FUEL OIL STORAGE TANK PIPING SPECIALTIES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Simplex
 - 2. Morrison Bros. Co.
 - 3. OPW.
 - 4. Preferred Utilities Manufacturing Corporation.

Project No. 121505 Facility Fuel-Oil Piping Section 22 6411.1 - 9

- B. Fitting Materials: malleable iron, brass, or corrosion-resistant metal; suitable for fuel-oil service.
 - 1. Surface, Flush-Mounted Fittings: Waterproof and suitable for truck traffic.
 - 2. Aboveground-Mounted Fittings: Weatherproof.
- C. Spill-Containment Fill Boxes: Flush mounting, with drainage feature to drain oil into tank, threaded fill-pipe connection, and wrench operation.
- D. Fill Boxes: Flush mounting, with threaded fill-pipe connection and wrench operation.
- E. Locking Fill Boxes: Flush mounting, with locking-type inner fill cap for standard padlock and threaded fill-pipe connection.
- F. Supply and Sounding Drop Tubes: Fuel-oil supply piping or fitting, inside tank, terminating 6 inches above bottom of tank, and with end cut at a 45-degree angle.
- G. Pipe Adapters and Extensions: Compatible with piping and fittings.
- H. Suction Strainers and Check Valves: Bronze or corrosion-resistant metal components.
- I. Foot Valves and Antisiphon Valves: Poppet-type, bronze or corrosion-resistant metal components.
- J. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.
- K. Metal Manholes: 22 inch minimum diameter frame and cover. Furnish manhole units of adequate size for access to fittings if size is not indicated.
- L. Monitoring Well Caps: Locking pipe plug and manhole.

2.10 LIQUID-LEVEL GAGE SYSTEM

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Veeder Root.
 - 2. Simplex
 - 3. Pneumercator Inc.
 - 4. Preferred Utilities Manufacturing Corporation.
- B. Description: Calibrated, liquid-level gage system complying with UL 180 with floats or other sensors and remote annunciator panel.
- C. Annunciator Panel: With visual and audible, high-tank-level and low-tank-level alarms, fuel indicator with registration in gallons, and overfill alarm. Include gage volume range that covers fuel-oil storage capacity.
- D. Controls: Electrical, operating on 120V ac.

2.11 LEAK-DETECTION AND MONITORING SYSTEM

- A. Containment Sump and Sensor System: Comply with UL 1238.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. PermAlert Model PAL-AT with leak detection cable suitable for fuel oil. Install per manufacturer guidelines.

- 2. Calibrated, leak-detection and monitoring system with probes and other sensors and remote alarm panel for fuel-oil piping.
- 3. Include fittings and devices required for testing.
- 4. Controls: Electrical, operating on 120-V ac.
- 5. Calibrated, liquid-level gage complying with UL 1238 with probes or other sensors and remote annunciator panel.

2.12 Controls: Electrical, operating on 120 –V:

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

2.13 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Advance Products & Systems, Inc.
 - b. Calpico Inc.
 - c. Metraflex Company (The).
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe and sleeve.
 - 3. Pressure Plates: Stainless steel.
 - 4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one nut and bolt for each sealing element.

2.14 ESCUTCHEONS

- A. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to fit around pipe or tube and with OD that completely covers opening.
- B. One-Piece, Cast-Brass Escutcheons: With set screw.
 - 1. Finish: Polished chrome-plated.
- C. Split-Casting, Cast-Brass Escutcheons: With concealed hinge and set screw.
 - 1. Finish: Polished chrome-plated.
- D. One-Piece, Floor-Plate Escutcheons: Cast-iron floor plate.
- E. Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

2.15 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Posthardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.

- 2. Design Mix: 5000-psi, 28-day compressive strength.
- 3. Packaging: Premixed and factory packaged.

2.16 LABELING AND IDENTIFYING

A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

2.17 CONCRETE MANHOLES

- A. Precast Concrete Manhole Sections: ASTM C 478, base and concentric-cone sections with integral ladder or steps.
- B. Cast-Iron Frame and Cover: Heavy-duty, water-resistant, cast-iron manhole frame, gasket, and bolted cover; 24-inch-diameter, inside opening dimension; 8-inch frame riser height.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine roughing-in for fuel-oil piping system to verify actual locations of piping connections before equipment installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 EARTHWORK

A. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.03 PREPARATION

- A. Close equipment shutoff valves before turning off fuel oil to premises or piping section.
- B. Comply with NFPA 30 and NFPA 31 requirements for prevention of accidental ignition.

3.04 OUTDOOR PIPING INSTALLATION

- A. Install underground fuel-oil piping buried at least 18 inches below finished grade. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.
 - 1. If fuel-oil piping is installed with less than 12 inches of cover to finished grade, install in containment piping.
 - 2. Follow manufacturer guidelines
- B. Steel Piping with Protective Coating:
 - 1. Apply joint cover kits to pipe after joining, to cover, seal, and protect joints.
 - 2. Replace pipe having damaged PE coating with new pipe.
- C. Install double-containment, fuel-oil pipe at a minimum slope of 1 percent downward toward fuel-oil storage tank sump.
- D. Install vent pipe at a minimum slope of 2 percent downward toward fuel-oil storage tank sump.

- E. Assemble and install entry boots for pipe penetrations through sump sidewalls for liquidtight joints.
- F. Install metal pipes and tubes, fittings, valves, and flexible connectors at piping connections to AST and UST.
- G. Install fittings for changes in direction in rigid pipe.
- H. Install system components with pressure rating equal to or greater than system operating pressure.
- I. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Install sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- J. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- K. Mechanical Sleeve Seal Installation: Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- L. Install pressure gage on suction from each pump. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."

3.05 INDOOR PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping free of sags and bends.
- G. Install fittings for changes in direction and branch connections.
- H. Install escutcheons for penetrations of walls, ceilings, and floors.
 - 1. New Piping:
 - a. Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - b. Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - c. Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - d. Piping in Equipment Rooms: One-piece, cast-brass type.
 - e. Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

- I. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."
- J. Verify final equipment locations for roughing-in.
- K. Comply with requirements for equipment specifications in Division 22 and Division 23 Sections for roughing-in requirements.
- L. Conceal pipe installations in walls, pipe spaces, or utility spaces; above ceilings; below grade or floors; and in floor channels unless indicated to be exposed to view.
- M. Prohibited Locations:
 - 1. Do not install fuel-oil piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
 - 2. Do not install fuel-oil piping in solid walls or partitions.
- N. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- O. Connect branch piping from top or side of horizontal piping.
- P. Install unions in pipes NPS 2 and smaller at final connection to each piece of equipment and elsewhere as indicated. Unions are not required on flanged devices.
- Q. Do not use fuel-oil piping as grounding electrode.
- R. Install Y-pattern strainer on inlet side of fuel-oil pump.

3.06 VALVE INSTALLATION

- A. Install manual fuel-oil shutoff valves on branch connections to fuel-oil appliance.
- B. Install valves in accessible locations.
- C. Protect valves from physical damage.
- D. Install metal tag attached with metal chain indicating fuel-oil piping systems.
- E. Identify valves as specified in Division 22 Section "Identification for PLUMBING Piping and Equipment."
- F. Install oil safety valves at inlet of each oil-fired appliance.
- G. Install pressure relief valves in distribution piping between the supply and return lines.
- H. Install manual air vents at high points in fuel-oil piping.

3.07 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

- D. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to "Quality Assurance" Article.
 - 1. Bevel plain ends of steel pipe.
 - 2. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.
- E. Fiberglass-Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.08 FUEL OIL UST INSTALLATION

- A. Excavate to sufficient depth for a minimum of 3-5 feet of earth cover from top of tank to finished grade. Allow for cast-in-place, concrete-ballast base plus 6 inches of sand or pea gravel between ballast base and tank. Extend excavation at least 12 inches around perimeter of tank.
- B. Set tie-down eyelets for hold-down straps in concrete-ballast base and tie to reinforcing steel.
- C. Place 6 inches of clean sand or pea gravel on top of concrete-ballast base.
- D. Set tank on fill materials and install hold-down straps.
- E. Connect piping.
- F. Install tank leak-detection and monitoring devices.
- G. Install containment sumps.
- H. Backfill excavation with clean sand or pea gravel in 12-inch lifts and tamp backfill lift to consolidate.
- I. Install filter mat between top of backfill material and earth fill.
- J. Install steel USTs with the STI-P3 corrosion-protection system according to STI R821 and STI R891. Protect anodes during tank placement and backfilling operations.
- K. Install composite, steel USTs according to STI R913 and STI R891.
- L. Install jacketed, steel USTs according to STI R923 and STI R891.
- M. Install FRP USTs with FRP hold-down straps, manhole extensions, and manhole risers.
- N. Fill storage tanks with fuel oil.
- O. Tank manufacturer guidelines shall be followed in case any of the above does not apply.

3.09 HANGER AND SUPPORT INSTALLATION

- A. Pipe hanger and support and equipment support materials and installation requirements are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 1-1/4 and Smaller: Maximum span, 84 inches; minimum rod size, 3/8 inch.
 - 2. NPS 1-1/2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 - 3. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
 - 4. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 1/2 inch.
 - 5. NPS 3: Maximum span, 12 feet; minimum rod size, 1/2 inch.
 - 6. NPS 4: Maximum span, 13 feet; minimum rod size, 5/8 inch.

C. Support vertical steel pipe at each floor and at spacing not greater than 15 feet.

3.10 CONNECTIONS

- A. Install piping adjacent to equipment to allow service and maintenance.
- B. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment having threaded pipe connection.
- C. Connect piping to equipment with ball valve and union. Install union between valve and equipment.
- D. Install flexible piping connectors at final connection to burners or oil-fired appliances that must be moved for maintenance access.

3.11 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplates and signs on or near each service regulator and service meter valve.
 - 1. Text: In addition to identifying unit, distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
- B. Install detectable warning tape directly above fuel-oil piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs. Terminate tracer wire in an accessible area, and identify as "tracer wire" for future use with plastic-laminate sign.
 - 1. Piping: Over underground fuel-oil distribution piping.
 - 2. Fuel-Oil Storage Tanks: Over edges of each UST.

3.12 FIELD PAINTING OF ABOVEGROUND PIPING

- A. Comply with requirements in Division 09 painting Sections for painting interior and exterior fuel-oil piping.
- B. Paint exposed, exterior metal piping, valves, and piping specialties, except components with factory-applied paint or protective coating.
 - 1. Alkyd System: MPI EXT 5.1D.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
 - c. Topcoat: Exterior alkyd enamel (semigloss).
 - d. Color: Gray.
- C. Paint exposed, interior metal piping, valves, and piping specialties, except components with factory-applied paint or protective coating.
 - 1. Alkyd System: MPI INT 5.1E.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Interior alkyd matching topcoat.
 - c. Topcoat: Interior alkyd (semigloss).
 - d. Color: Gray.
- D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.13 CONCRETE BASES

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 121505 Facility Fuel-Oil Piping Section 22 6411.1 - 16 A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions.

3.14 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. Piping: Minimum hydrostatic or pneumatic test-pressures measured at highest point in system:
 - a. Fuel-Oil Distribution Piping: Minimum 5 psig for minimum 30 minutes.
 - b. Fuel-Oil, Double-Containment Piping:
 - 1) Carrier Pipe: Minimum 5 psig for minimum 30 minutes.
 - 2) Containment Conduit: Minimum 5 psig for minimum 60 minutes.
 - c. Suction Piping: Minimum 20-in. Hg for minimum 30 minutes.
 - d. Isolate storage tanks if test pressure in piping will cause pressure in storage tanks to exceed 10 psig.
 - 2. Inspect and test fuel-oil piping according to NFPA 31, "Tests of Piping" Paragraph; and according to requirements of authorities having jurisdiction.
 - 3. Test liquid-level gage for accuracy by manually measuring fuel-oil levels at not less than three different depths while filling tank and checking against gage indication.
 - 4. Test leak-detection and monitoring system for accuracy by manually operating sensors and checking against alarm panel indication.
 - 5. Start fuel-oil transfer pumps to verify for proper operation of pump and check for leaks.
 - 6. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 7. Bleed air from fuel-oil piping using manual air vents.
- D. Fuel-oil piping and equipment will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.15 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain liquid-level gage systems, leak-detection and monitoring systems, and fuel-oil pumps.

3.16 OUTDOOR PIPING SCHEDULE

A. Underground fuel-oil piping shall be one of the following. Size indicated is carrier-pipe size.

Project No. 121505 Facility Fuel-Oil Piping Section 22 6411.1 - 17

- 1. Perma-Pipe Type FS Rigid, double-containment piping.
- B. Containment Conduit: FRP conduit, suitably sized as determined by the manufacturer.
- C. Aboveground fuel-oil piping shall be one of the following:
 - 1. NPS 2 and Smaller: Steel pipe, steel or malleable-iron threaded fittings, and threaded joints.
 - 2. NPS 2-1/2 and Larger: Steel pipe, steel welding fittings, and welded joints.

3.17 INDOOR PIPING SCHEDULE

- A. Aboveground fuel-oil piping shall be one of the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
 - 2. Steel pipe with wrought-steel fittings and welded joints.

3.18 ABOVEGROUND MANUAL FUEL-OIL SHUTOFF VALVE SCHEDULE

- A. Distribution piping valves for pipe NPS 2 and smaller shall be one of the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
- B. Distribution piping valves for pipe NPS 2-1/2 and larger shall be one of the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
 - 2. Bronze, nonlubricated plug valve.
- C. Valves in branch piping for single appliance shall be one of the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.

END OF SECTION 22 64 11

SECTION 22 6413.1 FACILITY FUEL OIL PUMPS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Submersible fuel-oil pumps in UST.

1.03 DEFINITIONS

- A. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- B. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- C. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, and dimensions of individual components and profiles.
 - 2. Include, where applicable, rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For fuel-oil pumps.
 - 1. Include construction details and dimensions of individual components for fuel-oil pumps.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 3. Scale: 1/4 inch per foot.
- C. Delegated-Design Submittal: For fuel-oil pumps. (WHEN REQUIRED)
 - 1. Detail fabrication and assembly of anchors and restraints.
 - 2. Design Calculations: Calculate requirements for selecting fuel pump.
 - 3. Detail fabrication and assembly of hangers, supports, and attachments of the same to building structure.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified professional engineer.
- B. Seismic Qualification Certificates: For fuel-oil pumps from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

- 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
- 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field quality-control reports.
- D. Sample Warranty: For special warranty.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuel-oil pumps and fuel-oil maintenance systems to include in emergency, operation, and maintenance manuals.

1.07 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. One set of spare filters for fuel maintenance system.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Maximum Operating-Pressure Ratings: 3-psig fuel-oil supply pressure at oil-fired appliances.
- B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design fuel-oil pumps, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine roughing-in for fuel-oil pumps to verify actual locations of pump connections before equipment installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 EARTHWORK

A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.03 PREPARATION

- A. Close equipment shutoff valves before turning off fuel oil to premises or piping section.
- B. Comply with NFPA 30 and NFPA 31 requirements for prevention of accidental ignition.

3.04 SUBMERSIBLE FUEL OIL PUMPS (SEE DRAWINGS)

- A. Description: Submersible Turbine Pump, Centrifugal multi-stage type, self-lubricating, with manifold head assembly. Pumps shall be as manufactured by Veeder Root (OR SIMILAR).
 - 1. Pump and motor assembly separate from the pump column pipe to allow for simple field replacement of the pump and motor.
 - 2. Pump impellers shall be splined to the pump shaft for non-slip rotation.
 - 3. Factory tested and certified.
 - 4. All components shall be designed and assembled to facilitate disassembly and servicing without disrupting the discharge piping; complete with built-in Check Valve pressure release, and mechanical or electronic line leak detection interface with tank gauging system for shutdown and alarm.
 - 5. Pump shall be assembled with the pump inlet and impellers at the bottom for maximum liquid draw.
 - 6. The motor shall be above pump inlet, so that the motor is both cooled and lubricated by the flow through and past the motor.
 - 7. The motor shall be 208/230 volt, 60Hz, single-phase, 3450 RPM, permanent split capacitor type continuous duty, rated explosion proof in Class 1, Group D, petroleum products. The motor windings shall be hermetically sealed against leakage of product or moisture, and shall have a thermal overload device with automatic reset built into the motor windings for motor cut-off when motor temperature reaches a level which may cause damage to the motor.
 - 8. Pump shall be adequate for fuel oil no. 2, UL-79 approved.
 - 9. Pump intake inlet openings shall be horizontal to prevent drawing sediment from the tank bottom into the pump inlet. The bottom of the inlet shall be a minimum of 5 inches to the bottom of the tank or as recommended by manufacturer. Provide intake screen.
 - 10. The length of the pump shall be of fixed length construction where the length is dependent upon riser length and tank diameter.
- B. Capacities and Characteristics: (see drawings)
 - 1. Electrical Characteristics:
 - a. Volts: 208.
 - b. Phase: 1.
 - c. Hertz: 60.
 - d. 3450 RPM

3.05 FUEL-OIL PUMP INSTALLATION

- A. SUBMERSIBLE FUEL OIL PUMPS
 - 1. Install pumps per manufacturer guidelines.
 - 2. Coordinate with tank manufacturer for manway and containment sump.
 - 3. Electrical installation per NEC.

3.06 LABELING AND IDENTIFYING

A. Install nameplates and signs on each fuel-oil pump. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment."

3.07 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 121505 Facility Fuel-Oil Pumps Section 22 6413.1 - 3

- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Start fuel-oil transfer pumps to verify for proper operation of pump, and check for leaks.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Fuel-oil pumps will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.08 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fuel-oil pumps.

END OF SECTION 22 64 13

SECTION 22 6700 PROCESSED WATER SYSTEMS FOR HEALTHCARE FACILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes deionized and reverse-osmosis water piping.

1.3 **DEFINITIONS**

- A. CPVC: Chlorinated polyvinyl chloride plastic.
- B. PP: Polypropylene plastic.
- C. PTFE: Polytetrafluoroethylene plastic.
- D. PVC: Polyvinyl chloride plastic.
- E. PVDF: Polyvinylidene fluoride plastic.

1.4 PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing piping with the following minimum working-pressure ratings, unless otherwise indicated:
 - 1. Deionized and Reverse-Osmosis Water Piping: 100 psig unless otherwise indicated.

1.5 SUBMITTALS

- A. Product Data: For each type of pipe and fitting indicated.
- B. Field quality-control test reports.

1.6 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing laboratory.
- B. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.
- C. ASME Compliance: Comply with ASME B31.3, "Process Piping."

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic pipe and fittings in direct sunlight.
- B. Protect pipe and fittings from dirt and damage.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following.

2.2 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, fitting, and joining materials.
- B. Transition Fittings: Couplings, flanges, or other manufactured fittings, same size as, with pressure rating at least equal to and ends compatible with piping to be joined.

2.3 PLASTIC PIPE AND FITTINGS

- A. PP Pipe and Fittings: Made from ASTM D 4101, PP resin.
 - 1. Manufacturers:
 - a. Fischer, George Inc.
 - b. IPEX Inc.
 - c. NIBCO INC.
 - d. Orion.
 - 2. Schedule 40, Pipe and Fittings: Pipe made to ASTM D 2447, Schedule 40 dimensions and socket- or butt-fusion fittings matching pipe Schedule 40 dimensions.
- B. PVDF Pipe and Fittings: Made from ASTM D 3222, PVDF resin.
 - 1. Manufacturers:
 - a. Fischer, George Inc.
 - b. NIBCO INC.
 - c. Orion.
 - 2. Schedule 40, Pipe and Fittings: Pipe made to ASTM D 2447, Schedule 40 dimensions and socket- or butt-fusion fittings matching pipe Schedule 40 dimensions.

2.4 STAINLESS-STEEL PIPE AND FITTINGS

A. Stainless-Steel Pipe and Fittings: Schedule 10, ASTM A 312/A 312M, Grade TP304L or TP316L, unless otherwise indicated; seamless pipe and ASTM A 403/A 403M, Class S, seamless fittings matching pipe thickness and grade, for welded joints.

2.5 PLASTIC VALVES

A. PP Valves: Made from ASTM D 4101, PP resin.

- 1. Ball Valves, NPS 2 and Smaller: MSS SP-122, union type with socket ends and pressure rating not less than 150 psig at 73 deg F.
- 2. Check Valves: Swing or ball type with pressure rating not less than 150 psig at 73 deg F.
- B. PVDF Valves: Made from ASTM D 3222, PVDF resin:
 - 1. Ball Valves, NPS 2 and Smaller: MSS SP-122, union type with socket ends and pressure rating not less than 150 psig at 73 deg F.
 - 2. Check Valves: Swing or ball type with pressure rating not less than 150 psig at 73 deg F.

2.6 STAINLESS-STEEL VALVES

- A. Manufacturers:
 - 1. Conbraco.
 - 2. Foster Valve Co.
 - 3. Jamesbury, Inc.
 - 4. Marvin Ball Valves; a division of Richards Industries.
 - 5. NIBCO INC.
- B. Ball Valves, NPS 2 and Smaller: MSS SP-110, 600-psig minimum CWP, 2 piece, with stainless-steel body, full port stainless-steel ball, PTFE seals, and threaded or weld ends.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Transition and special fittings with pressure ratings at least equal to and of material same as, or compatible with, piping may be used in applications in this article, unless otherwise indicated.
- B. Deionized and Reverse-Osmosis Water Piping: Use any of the following piping materials for each size range:
 - 1. NPS 1 and Smaller: Schedule 40 PP pipe and fittings and heat-fusion joints.
 - 2. NPS 1-1/4 to NPS 2: Schedule 40 PP pipe and fittings and heat-fusion joints.

3.2 VALVE APPLICATIONS

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirement apply:
 - 1. Shutoff Duty: Use ball, diaphragm, or plug valves for NPS 2 and smaller.
 - 2. Throttling Duty: Use ball, diaphragm, or plug valves for NPS 2 and smaller.
- B. Valves for Deionized and Reverse-Osmosis Water Piping: Use any of the following valves for each piping material:
 - 1. PP Pipe and Fittings: PP plastic valves.
 - 2. PVDF Pipe and Fittings: PVDF plastic valves.

3.3 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of deionized and reverse-osmosis water piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Refer to Division 22 Section "Common Work Results for Plumbing" for general piping installation requirements.

3.4 JOINT CONSTRUCTION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for basic piping joint construction. Where specific joint construction is not indicated, follow piping manufacturer's written instructions.
- B. PDVF Piping Joints: Make heat-fusion joints similar to procedure in ASTM D 2657 for polyolefin piping joints.
- C. Joint dissimilar pipe materials with transition fittings compatible with pipe materials being joined.

3.5 VALVE INSTALLATION

- A. Refer to Division 22 Section "General-Duty Valves for Plumbing Piping" for general valve installation requirements.
- B. Install sectional valves close to mains on each branch and riser serving equipment.
- C. Install shutoff valve on each supply to equipment.

3.6 HANGER AND SUPPORT INSTALLATION

- A. Pipe hanger and support devices and installation requirements are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:
 - 1. Clamps for Vertical Piping: MSS Type 8 or Type 42.
 - 2. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Support horizontal piping and tubing within 12 inches of each fitting, valve and coupling.
- C. Support vertical piping and tubing at base and at each floor.

- D. Rod diameter may be reduced 1 size for double-rod hangers, to minimum of 3/8 inch.
- E. Install padded hangers for PP piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4 and Smaller: 30 inches with 3/8-inch rod.
 - 2. NPS 1-1/2: 33 inches with 3/8-inch rod.
 - 3. NPS 2: 36 inches with 3/8-inch rod.
- F. Install padded supports for vertical PP piping every 42 inches.
- G. Install padded hangers for PVDF piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1 and Smaller: 30 inches with 3/8-inch rod.
 - 2. NPS 1-1/4: 33 inches with 3/8-inch rod.
 - 3. NPS 1-1/2 and NPS 2: 36 inches with 3/8-inch rod.
 - 4. NPS 8: 48 inches with 7/8-inch rod.
- H. Install padded supports for vertical PVDF piping NPS 1-1/2 and smaller every 48 inches and NPS 2 and larger every 72 inches.
- I. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment and machines to allow service and maintenance.
- C. Connect deionized and reverse-osmosis water piping to equipment and service outlets with unions or flanges.

3.8 LABELING AND IDENTIFICATION

A. Install pipe markers and valve tags on piping. Distinguish between different systems and include direction of flow indication on each pipe. Labeling and identification devices are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.9 FIELD QUALITY CONTROL

- A. Test new piping and parts of existing piping that have been altered, extended, or repaired, for leaks and defects.
 - 1. Schedule tests and their inspections by authorities having jurisdiction, with at least 24 hours' advance notice.
 - 2. Do not cover or put into service before inspection and approval.
 - 3. Test completed piping according to authorities having jurisdiction. If authorities having jurisdiction do not have published procedures, perform tests as follows:
 - a. Hydrostatic Tests: Test piping at pressure not less than 1-1/2 times the maximum system operating pressure, but not less than 100 psig.

- 4. Replace leaking joints with new materials and retest until no leaks exist.
- 5. Submit separate reports for each test.

3.10 CLEANING

- A. Use procedures prescribed by authorities having jurisdiction or, if not prescribed, use procedures described below:
 - 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 - 2. Clean piping by flushing with system deionized and reverse-osmosis water.

END OF SECTION 22 6700

SECTION 22 6719 PROCESSED WATER EQUIPMENT FOR LABORATORY AND HEALTHCARE FACILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes reverse-osmosis-water equipment. Equipment and associated control and accessories shall be capable of producing 7500 gallons per day of AAMI grade water.
 1. RO systems.
- B. Related Requirements:
 - 1. Section 22 6713 "Processed Water Piping for Laboratory and Healthcare Facilities" for piping, fittings, and valves.

1.3 **DEFINITIONS**

A. RO: Reverse osmosis.

1.4 ACTION SUBMITTALS

- A. Product Data for each type of product, including the following.
 - 1. Pump curves.
 - 2. Equipment dimensions and weight data.
 - 3. Electrical wiring data.
 - 4. Control panel layout.
 - 5. Vibration data.
- B. Shop Drawings:
 - 1. Provide a flow schematic of the proposed system, showing:
 - a. Equipment and accessories.
 - b. Piping and directional flows and sizes.
 - c. Flow rates.
 - d. Connection to domestic water.
 - e. Components.
 - f. Interconnection piping.

1.5 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Data: For equipment, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Field quality-control reports.
- C. Operation and Maintenance Data: For all equipment in this section.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer shall have the qualifications for supplying and servicing process water equipment, including engineering services.
- B. The process water quality shall be in accordance with ASTM D1193.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain processed water equipment from single source.

2.2 PERFORMANCE REQUIREMENTS

- A. Design equipment based on the city of Lake Mary make-up water conditions obtained from the city water supply quality report.
 - 1. RO Water Piping: 50 psig unless otherwise indicated.
- B. Seismic Performance: Water piping shall withstand the effects of earthquake motions determined according to [ASCE/SEI 7] < Insert requirement >.
 - 1. The term "withstand" means "the equipment will remain in place without separation of any parts when subjected to the seismic forces specified[and the equipment will be fully operational after the seismic event]."
 - 2. Component Importance Factor: [1.5] [1.0].
 - 3. <Insert requirements for Component Amplification Factor and Component Response Modification Factor>.

2.3 REVERSE OSMOSIS (RO) SYSTEMS

A. Pressurized Membrane System: High-pressure pump forces water through the membrane(s) to remove 99 percent of organic solids, bacteria, contaminants, and particles and 97 percent of dissolved solids.

- B. Pre-filtration: Polypropylene depth filters, capable of removing 90 percent of particles greater than 5 micron.
 - 1. Housing:
 - a. [Type 304] [Type 316] stainless steel.
 - b. Include vent and drain plugs with EPDM o-rings.
 - c. Include [**Type 304**] [**Type 316**] pressure gauge at the inlet and outlet.
- C. Membrane modules with thin-film composite type membranes and membrane vessels to allow a maximum flux for the following:
 - 1. First State: [18 gallons per square foot per day (733 liters per square meter per day)] <Insert capacity> of membrane surface area at [17] <Insert number> percent recovery.
 - Second Stage: [30 gallons per square foot (114 liters per square meter per day)] <Insert number> per day of membrane surface area at [35] <Insert number> percent recovery.
- D. Panel-Mounted Controls and Instrumentation on a Common Frame:
 - 1. Material: [Stainless steel] [Epoxy-coated aluminum].
 - 2. Features:
 - a. Flow meters
 - b. **[Type 304] [Type 316]** stainless steel pressure gauges for pump discharge and regulated pump pressure.
 - c. Control valves.
 - d. Pump starter with indicated light.
 - e. Feedwater pressure switch with time delay for low-pressure shutdown.
 - f. Time controller for automatic fast flush.
 - g. Monitor/controller with selector switch for feed to monitor conductivity.
 - h. Trouble alarm with ability to connect to the building management system.

2.4 PURIFED-WATER STORAGE TANK

- A. Material: Fabricated of molded polyethylene with a cone bottom and extra heavy wall construction. Provide with [two] [four] lifting lugs of [Type 304] [Type 316] stainless steel.
- B. Mounting: Steel stand assembly with hold-down lugs of Type 304 stainless steel.

2.5 RECIRCULATING PUMP

- A. Type: Vertical.
- B. Pump Material: [**Type 304**] [**Type 316**] stainless steel.
- C. Impeller Material: Stainless steel.
- D. Seals: Mechanical.
- E. Gaskets: Teflon.

F. Size and capacity: 185 gallon.

2.6 ULTRA-VIOLET STERILIZATION UNIT

- A. < Double click here to find, evaluate, and insert list of manufacturers and products.>
- B. Inline Sterilizer Light: Provide to reduce the bacteria.
- C. Ultra-Violet Lamps: < Insert number> ultra-violet lamp(s), designed to operate at 115 V, single phase, 60 Hz.
 - 1. Housing: Type 304, electro-polished and passavated stainless steel, complying with MIL-S-5002.
- D. Provide a sensor that will be able to indicate level of UV radiation being produced.

2.7 SOURCE QUALITY CONTROL

A. Manufacturer to perform a factory test of components, piping, and skid assemblies prior to shipment and furnish certification that the testing has been performed and the certification meets specified design requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General Locations and Arrangements: Drawings and details indicate general location and arrangement of water piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install seismic restraints on equipment. Comply with requirements for seismic-restraint devices specified in Section 22 0548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- C. Install equipment in accordance with all codes, standards, and manufacturers recommendations.
- D. Provide documentation that the equipment has been installed in accordance with manufacturers requirements.
- E. Provide a startup of the equipment and a per-check of all associated piping, valves, control devices and control panels.
- F. After completion of the installation, provide up to eight hours of instructional time with the Owner's personnel.
- G. Mount equipment and/or skid(s) on concrete pads.

H. Connect, calibrate, balance, and adjust equipment, devices, and instrumentation to perform functions as specified.

3.2 PIPING CONNECTIONS

- A. Drawings indicate general arrangement of equipment, piping, fittings, and specialties.
- B. Where installing equipment, allow space for service and maintenance.
- C. Connect RO water piping to equipment and service outlets with unions or flanges.

3.3 IDENTIFICATION

A. Comply with requirements for identification specified in Section 22 0553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections with the assistance of a factory-authorized service representative.
- E. Tests and Inspections:
 - 1. After installation, Installer shall test equipment for performance, leaks, and defects.
 - 2. The Installer shall notify the Architect and engineer and Owner, with at least 24 hours' advance notice.
 - 3. Do not cover equipment or put into service before inspection and approval by the Architect and engineer and Owner.
 - 4. Submit separate reports for each test.
- F. Processed-water system will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.

3.5 SANITIZING OF EQUIPMENT SERVING HEALTHCARE

- A. Use procedures prescribed by authorities having jurisdiction or, if not prescribed, use procedures described below:
 - 1. Cleaning of system as indicated or in accordance with AWWA-C601.
 - 2. Remove flow indicators and flow measuring devices before flushing. Replace after cleaning is completed.
 - 3. Sanitize equipment by flushing at a sufficient velocity and quantity to dislodge sediment or dirt with reverse-osmosis water mixture throughout the system.

- 4. Opening and closing valves several times collecting samples from various fixtures throughout the system during introduction of chlorine to assure uniform distribution.
- 5. After flushing provide evidence of effectiveness of disinfection by filing a report with the engineer, laboratory reports of bacteriological tests on samples taken from the system. The report shall include the number and locations of where the samples where taken.
- 6. If satisfaction is not achieved, repeat the above disinfection process until satisfactory results are obtained. And do not put the system online until this has been obtained.

3.6 SANITIZING OF EQUIPMENT SERVING LABORATORIES

- A. Use procedures prescribed by authorities having jurisdiction, Owner or, if not prescribed, use procedures described below:
 - 1. Remove flow indicators and flow-measuring devices before flushing. Replace after cleaning is completed.
 - 2. Clean equipment by pumping at a sufficient velocity and quantity to dislodge sediment or dirt with sodium hypochlorite and a RO- water mixture throughout the system.
 - 3. Open all taps until solution is detected, then close taps. Retain solution in the system at least three hours.

END OF SECTION 22 6719

SECTION 23 0100 BASIC MECHANICAL REQUIREMENTS

PART1- GENERAL

1.1 RELATED DOCUMENTS

- A. Basic Requirements: Requirements of the Contract Forms, Conditions of the Contract, Specifications, Drawings, and Addenda and Contract Modifications (the Contract Documents), apply to the requirements of each Section of Division 23.
- B. Conflicts: Nothing contained in this Section shall be construed to conflict in any way with other provisions or requirements of the Contract documents. The intent is that this Section will take precedence. Where differences arise, the Architect shall decide which directions or instructions take precedence.

1.2 SUMMARY

A. General: Unless an item is specifically mentioned as being provided by others, the requirements of Division 23 Contract Documents shall be completed. The systems, equipment, devices and accessories shall be installed, finished, tested and adjusted for continuous and proper operation. Any apparatus, material or device not shown on the Drawings but mentioned in these Specifications, or vice versa, or any incidental accessories necessary to make the project complete and operational in all respects, shall be furnished, delivered and installed without additional expense to the Owner. Include all materials, equipment, supervision, operation, methods and labor for the fabrication, installation, start-up and tests necessary for complete and properly functioning systems.

1.3 APPLICABLE STANDARDS

- A. Code Compliance: Refer to Division 1. As a minimum, unless otherwise indicated, comply with all rules, regulations, standards, codes, ordinances and laws of local, state and federal governments and the amendments and interpretation of such rules, regulations, standards, codes, ordinances and laws of local, state and federal governments by the authorities having lawful jurisdiction.
- B. ADA: Comply with the requirements of the Americans with Disabilities Act (ADA).
- C. Comply: With the National Fire Protection Association (NFPA) Standards and other Codes and Standards as adopted by the Local Authority having Jurisdiction.
- D. Florida Building Code 2020 Edition: Conform in strict compliance to the Florida Building Code (FBC) and the amendments which are enforced by the local authority having jurisdiction.
 - 1. Florida Building Code Mechanical 2020 Edition
 - 2. Florida Building Code Plumbing 2020 Edition
 - 3. Florida Building Code Fuel Gas 2020 Edition
 - 4. Florida Building Code Chapter 13 Florida Energy Efficiency for Building Construction 2020 Edition
 - 5. FGI Guidelines for Design and Construction of Healthcare Facilities, American 2018 Edition.
- E. NATIONAL FIRE PROTECTION (NFPA) Standards:

- 1. NFPA-54, National Fuel Gas Code, 2018 Edition
- 2. NFPA-58, Standard for Storage and Handling of Liquefied Petroleum Gases, 2017 Edition
- 3. NFPA-70, National Electrical Code, 2017 Edition
- 4. NFPA-99, Standard for Health Care Facilities, 2018 Edition
- 5. NFPA-101, Life Safety Code, 2018 Edition
- F. Notification: Comply with all of the requirements of the Federal "Right-To-Know" Regulations and the Florida "Right-To-Know" Law and provide notification to all parties concerned as to the use of toxic substances.
- G. Owner Design Guidelines: Comply with all the requirements of the latest Owner MEP Engineering Design Guidelines and the latest Owner Architectural Construction Standards.

1.4 DRAWINGS AND SPECIFICATIONS

- A. Intent: The intent of the drawings and specifications is to establish minimum acceptable quality standards for materials, equipment and workmanship, and to provide operable mechanical systems complete in every respect.
- B. Equipment Placement: The drawings are diagrammatic, intended to show general arrangement, capacity and location of various components, equipment and devices. Each location shall be determined by reference to the general building plans and by actual measurements in the building as built. Reasonable changes in locations ordered by the Architect prior to the performance of the affected Work shall be provided at no additional cost to the Owner.
- C. Drawing Scale: Due to the small scale of the drawings, and to unforeseen job conditions, all required offsets, transitions and fittings may not be shown but shall be provided at no additional cost.
- D. Conflict: In the event of a conflict, the Architect will render an interpretation in accordance with the General Conditions.

1.5 DEFINITIONS

- A. Provide/Install: The word "provide" shall mean furnish, install, connect, test, complete, and leave ready for operation. The word "install" where used in conjunction with equipment furnished by the Owner or under another contract shall mean mount, connect, complete, and leave ready for operation.
- B. Concealed: The surface of insulated or non-insulated piping, ductwork or equipment is concealed from view when standing inside a finished room, such as inside a chase or above a ceiling.
- C. Exposed: The surface of insulated or non-insulated piping, ductwork or equipment is seen from inside a finished room, such as inside an equipment or air handling unit room.
- D. Protected: The surface of insulated or non-insulated piping, ductwork or equipment on the exterior of the building but protected from direct exposure to rain by an overhang, eave, in an unconditioned parking garage or building crawl space.

- E. Unprotected: The surface of insulated or non-insulated piping, ductwork or equipment on the exterior of the building and exposed to rain.
- F. Abbreviations: Abbreviations, where not defined in the Contract Documents, shall be interpreted to mean the normal construction industry terminology, as determined by the Architect. Plural words shall be interpreted as singular and singular words shall be interpreted as plural where applicable for context of the Contract Documents.

1.6 SHOP DRAWINGS

- A. General: Refer to paragraph entitled "SUBMITTAL" in this section. Include the following data:
 - 1. Shop Drawings:
 - a. Submit shop drawings for the following:
 - (1) Each Piping System
 - (2) Ductwork systems as defined in Section 23 3113
 - (3) Coordination Drawings

1.7 RECORD DRAWINGS

- A. Production: Maintain one set of black or blue line on white project record "as-built" drawings at the site. At all times the set shall be accurate, clear, and complete, indicating the actual installation. Record drawings shall be updated weekly to record the present stage of progress. These drawings shall be available to the Architect at all times. Equipment schedules, control diagrams, sequences of operation shall also be updated.
- B. Completion: Prior to substantial completion, transfer onto an unmarked second set of drawings all changes, marked in colored pencil, and submit them to the Architect. Upon completion of all punch lists, transfer all "As-Built" conditions to the Rivet drawing files, package three (3) print sets of full size drawings and two (2) CDs of the Rivet drawing files with associated reference files and submit them to the Architect for review and approval.

1.8 SUBMITTAL

- A. General: The provisions of this section are supplemental to the requirements in Division 1, and only apply to the material and equipment covered in Division 23.
- B. Time: Submit manufacturer's literature, performance data and installation instructions covered in each Section of Division 23 under an individual letter of transmittal within 30 days after Notice to Proceed unless otherwise indicated.
- C. Submitter's Review: All items required for each section shall be reviewed before submittal. Submittal information for each item shall bear a review stamp of approval, indicating the name of the Contractor and Subcontractor (where applicable), the material suppliers, the initials of submitter and date checked. Responsibility for errors or omissions in submittals shall not be relieved by the Architect's review of submittals. Responsibility for submittals cannot be subrogated to material suppliers by Contractors or Subcontractors.

- 1. Review of the submittal data, whether indicated with "APPROVED" or with review comments, does not constitute authorization for or acceptance of a change in the contract price.
- D. Architect's Review: The submittal data shall be reviewed only for general conformance with the design concept of the project and for general compliance with the Contract Documents. Any action indicated is subject to the requirements of the Contract Documents. Reviews of submittal data review shall not include quantities; dimensions (which shall be confirmed and correlated at the job site); fabrication processes; techniques of construction; and co-ordination of the submittal data with all other trades. Copies of the submittal data will be returned marked "ACCEPTED AS SUBMITTED", "ACCEPTED AS NOTED", "REVISED AS NOTED AND RESUBMIT", "REJECTED, REVISED AS NOTED AND RESUBMIT".
- E. Submittal Items: Submittal items shall be inserted in a Technical Information Brochure. Mark the appropriate specification section or drawing reference number in the right hand corner of each item. All typewritten pages shall be on the product or equipment manufacturer's printed letterhead.
 - 1. Manufacturer's Literature: Where indicated, include the manufacturer's printed literature. Literature shall be clearly marked to indicate the item intended for use.
 - 2. Performance Data: Provide performance data, wiring and control diagrams and scale drawings which show that proposed equipment will fit into allotted space (indicate areas required for service access, connections, etc.), and other data required for the Architect to determine that the equipment complies with the Contract Documents. Where noted, performance data shall be certified by the manufacturer at the design rating points.
 - 3. Installation Instructions: Where requested, each product submittal shall include the manufacturer's installation instructions. Generic installation instructions are not acceptable. Instructions shall be the same as those included with the product when it is shipped from the factory.
 - 4. Written Operating Instructions: Instructions shall be the manufacturer's written operating instructions for the specified product. If the instructions cover more than one model or type of product they shall be clearly marked to identify the instructions that cover the product delivered to the project. Operating Instructions shall be submitted immediately after the product or equipment submittal has been returned from the Architect marked "APPROVED" or "APPROVED AS NOTED".
 - 5. Maintenance Instructions: Information shall be the manufacturer's printed instructions and parts lists for the equipment furnished. If the instructions cover more than one model or type of equipment they shall be marked to identify the instructions for the furnished product. Submit maintenance instructions immediately after the product or equipment submittal has been returned from the Architect marked "APPROVED" or "APPROVED AS NOTED".
- F. Substitutions:
- 1. General: Refer to Division 1. Substitutions may be considered for any product or equipment of a manufacturer. See paragraph entitled "MANUFACTURER" in this Section. Any product or equipment may be submitted for review; however, only one substitution per item will be considered. If a substituted product or equipment item is rejected, provide the specified product or equipment.
 - a. Submittal shall include the name of the material or equipment to be substituted, equipment model numbers, drawings, catalog cuts, performance and test data and any other data or information necessary for the Architect to determine that the equipment meets the specification requirements. If the Architect accepts any proposed substitutions, such acceptance will be set forth in writing.
 - b. Substituted equipment with all accessories installed or optional equipment where permitted and found acceptable, must conform to space requirements. Substituted equipment that cannot meet space requirements, whether accepted or not, shall be replaced at no additional expense to the Owner. If the substituted item affects the work of other trades, the Request for Substitution form shall include a list of the necessary modifications.
- 2. Deviations: The Request for Substitution form shall include a complete list of deviations from the scheduled item stating both the features and functions of the scheduled item and the comparable features and functions of the proposed substitution.
 - a. Any deviation not indicated in writing will be assumed to be identical to the specified item even if it is shown otherwise on the submittal data.
 - b. If a deviation not listed is found any time after review and acceptance by the Architect and that deviation, in the opinion of the Architect, renders the substituted item as unacceptable, the item shall be removed and replaced by the scheduled item at no additional cost to the Owner.
 - c. The Architect shall retain the right to specify modifications to the substituted item, correcting or adjusting for the deviation, if the Architect deems it to be in the best interest of the Owner.
- 3. Scheduled Item: A scheduled item is a product or item of equipment indicated in the Contract Documents by manufacturer's name and model number identifying a single item. The manufacturer's trade name for a group of products that does not signify a single item including type, style, quality, performance, and sound rating shall not be classified as a scheduled item. Where more than one manufacturer and product model number are indicated, each shall be considered as a scheduled item.
- 4. Form: When a product or item of equipment is proposed as a substitution a "REQUEST FOR SUBSTITUTION" form shall be completed and submitted with the required data. A copy of the form is included after the end of this section.
- 5. Rejection: Substituted products or equipment will be rejected if, in the opinion of the Architect, the submittal does not meet any one of the following conditions or requirements:
 - a. The submittal data is insufficient or not clearly identified. The Architect may or may not request additional information.

- b. The product or equipment will not fit the space available and still provide the manufacturers published service area requirements.
- c. The product or equipment submitted is not equivalent to or better than the specified item. Products or equipment of lesser quality may be considered provided an equitable financial rebate, satisfactory to the Architect, is to be returned to the Owner.
- d. The product or equipment submitted has less capacity, efficiency and safety provisions than the specified item.
- e. The product or equipment submitted does not have warranty, service and factory representation equivalent to that specified.
- f. The Owner prefers not to accept the submitted product.
- G. Technical Information Brochure:
 - 1. Binder: Include binders with the first submittal for the Technical Information Brochure. Each binder shall be size 3 inch, hardcover, 3-ring type for 8-1/2" X 11" sheets. Provide correct designation on outside cover and on spine of each binder, i.e., MECHANICAL SUBMITTAL DATA, MECHANICAL OPERATION INSTRUCTION and MECHANICAL MAINTENANCE INSTRUCTIONS.
 - 2. Number: Submit not less than five sets of binders for each of the three mechanical brochures indicated above. Each set shall consist of a minimum of two binders for submittal data and 1 binder each for operating instructions and for maintenance instructions. Additional binders shall be submitted at the request of the Architect. One set of binders shall be retained by the Architect. Three sets of binders shall be maintained for the Owner and the remaining set shall become the property of the Engineer.
 - 3. Index: First sheet in each brochure shall be a photocopy of the "Division 23 Index" of the specifications. Second sheet shall list the firm name, address, phone number, superintendent's name for the contractor and all major subcontractors and suppliers associated with the project.
 - 4. Dividers: Provide reinforced separation sheets tabbed with the appropriate specifications Section reference number for each Section in which submittal data or operation and maintenance instructions is required.
 - 5. Specifications: Insert a copy of the specifications for each Section and all addenda applicable to the Section between each of the Section dividers.

1.9 SHOP DRAWINGS FOR PIPING SYSTEMS

- A. Requirements: Make Shop Drawings for piping systems at a minimum scale of 1/4 inch per foot in AutoCAD and print on reproducible transparencies to verify clearances and equipment locations. Show required maintenance and operational clearances. Identify Shop Drawings by project name and include names of Architect, Engineer, Contractors, Subcontractors and supplier, date in Shop Drawing title block. Number drawings sequentially and indicate:
 - 1. Architectural and structural backgrounds with room names and numbers, etc., including but not limited to plans, sections, elevations, details, etc.
 - 2. Fabrication and erection dimensions.
 - 3. Arrangements and sectional views.

- 4. Necessary details, including complete information for making connections to equipment.
- 5. Descriptive names of equipment.
- 6. Modifications and options to standard equipment required by Contract Documents.
- B. Stamp Area: Leave 4 inch by 2-1/2 inch blank area near title block for Architect's shop drawing stamp. The acceptance of a shop drawing by indicating "APPROVED" does not relieve the contractor from full compliance with the sizes and equipment connections shown on the contract documents unless the changes are specifically indicated on the shop drawing.
- C. Reference Key: Indicate by cross-reference the Contract Drawings, notes, or Specification paragraph numbers where item(s) occur in the Contract Documents.
- D. Additional Requirements: See specific Sections for additional requirements.

1.10 SHOP DRAWINGS FOR DUCT SYSTEMS

- A. Requirements: Make Shop Drawings for duct systems at a minimum scale of 1/4 inch per foot in AutoCAD and print on reproducible transparencies to verify clearances and equipment locations. Show required maintenance and operational clearances. Identify Shop Drawings by project name and include names of Architect, Engineer, Contractors, Subcontractors and supplier, date in Shop Drawing title block. Number drawings sequentially and indicate:
 - 1. Architectural and structural backgrounds with room names and numbers, etc., including but not limited to plans, sections, elevations, details, etc.
 - 2. Fabrication and erection dimensions.
 - 3. Arrangements and sectional views.
 - 4. Necessary details, including complete information for making connections to air distribution devices and air handling equipment.
 - 5. Kinds of materials and finishes.
 - 6. Descriptive names of equipment.
 - 7. Modifications and options to standard equipment required.
- B. Stamp Area: Leave 4 inch by 2-1/2 inch blank area near title block for Architect's shop drawing stamp. The acceptance of a shop drawing by indicating "APPROVED" does not relieve the contractor from full compliance with the sizes and connections shown on the contract documents unless the changes are specifically indicated on the shop drawing.
- C. Reference Key: Indicate by cross-reference the Contract Drawings, notes, or Specification paragraph numbers where item(s) occur in the Contract Documents.
- D. Ceiling Plans: Provide Shop Drawings, using architectural reflected ceiling plans, which indicate locations of exposed air distribution devices, sprinkler heads, lights and access panel.
- E. Additional Requirements: See specific Sections for additional requirements.

1.11 COORDINATION DRAWINGS

A. General: Provide detailed (minimum 1/4 inch per foot) scaled coordination drawings showing locations and positions of all architectural, structural, (FF&E) equipment,

electrical, plumbing, fire protection and mechanical elements for all installations. Provide overlay drawings, prior to beginning work, indicating work in and above ceilings and in mechanical and electrical rooms with horizontal and vertical dimensions, to avoid interference with structural framing, ceilings, partitions and other services. Accommodate phasing and temporary conditions indicated on the contract drawings as necessary to complete the work without disruption to the Owner's use of the existing occupied areas of the building(s).

- B. Coordination of Space: Coordinate use of project space and sequence of installation of mechanical and electrical work which is indicated diagrammatically on drawings. Follow routings shown for pipes, ducts and conduits as closely as practicable, with due allowance for available physical space; make runs parallel with lines of building. Utilize space efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
- C. In finished areas except as otherwise shown, conceal pipes, ducts, and wiring in construction. Coordinate locations of fixtures and outlets with finish elements. Contractor shall provide background drawings showing partitions, ceiling heights, and structural framing locations and elevations, and existing obstructions. Contractor shall resolve major interferences at initial coordination meeting prior to production of coordination drawings.
- D. Precedence of Services: In event of conflicts and interferences involving location and layout of work, use the following priority to resolve interferences:
 - 1. Structure has highest priority.
 - 2. Walls systems.
 - 3. Ceiling grid/light fixtures.
 - 4. Gravity drainage lines.
 - 5. Large pipe mains.
 - 6. Ductwork/diffusers, registers and grilles.
 - 7. Sprinkler heads.
 - 8. Small piping and tubing/electrical conduit.
 - 9. Access panels.
- E. Drawings shall be developed on AutoCAD, and utilize AIA Standard layering conventions. At the completion of the project construction, the Contractor shall provide two (2) fullsized print sets and two (2) CDs of all drawing files with related reference files representing as-built installations for Architect review. Upon approval that the submitted information is complete, a similar submittal shall be provided to the Owner.
- F. Reference Key: Indicate by cross-reference the Contract Drawings, notes, or Specification paragraph numbers where item(s) occur in the Contract Documents.
- G. Additional Requirements: See specific Sections for additional requirements.

1.12 MANUFACTURER'S CHECKOUT

A. Start-up and Checkout: At completion of installation and prior to performance verification, a factory-trained representative of the manufacturer shall provide start-up and checkout service. After the performance verification the manufacturer's representative shall examine performance information and check the equipment in operation, and sign "Check-Out Memo" for the record. Submit a copy of Memo on each item of equipment where indicated in individual sections of these specifications for inclusion in each Technical Information Brochure. The "Check-Out Memo" shall be included with the performance verification data. Do not request "Instruction in Operation Conference" or request final inspection until Memos have been submitted and found acceptable.

1.13 INSTRUCTION TO OWNER

- A. General: Instructions to the Owner shall be by competent representatives of the manufacturers involved, with time allowed for complete coverage of all operating procedures. Provide classroom instruction and field training in the design, operation and maintenance of the equipment and troubleshooting procedures. Explain the identification system, operational diagrams, emergency and alarm provisions, sequencing requirements, seasonal provisions, security, safety, efficiency and similar provisions of the systems. On the date of substantial completion, turn over the prime responsibility for operation of the mechanical equipment and systems to the Owner's operating personnel.
- B. Training Period: Unless otherwise indicated training periods shall encompass the following number of hours of classroom and hands-on instructions with a maximum period of 4 hours per day for either. Mixing classroom instructions and hands on training in the same day is unacceptable.
 - 1. Training Periods:
 - a. 8 hours Classroom
 - b. 4 hours Hands-on
- C. Scheduling: Submit any remaining required items for checking at least one week before final inspection of building. When submittal items are found acceptable, notify Owner, in writing that an "Instruction in Operation Conference" may proceed. Conference will be scheduled by the Owner. After the conference, copies of a memo certifying that the "Instruction in Operation Conference" and "Completed Demonstration" have been made will be signed by Owner and the instructors, and one copy will be inserted in each Technical Information Brochure.

1.14 ALLOWANCES

- A. General: Division 1.
- 1.15 ALTERNATES
 - A. Refer to Division 1.
- 1.16 STRUCTURAL CALCULATIONS FOR ROOF-MOUNTED EQUIPMENT
 - A. All roof-mounted devices, equipment and systems shall be constructed, designed and fastened to withstand wind loads of velocities up to 155 mph. Structural calculations for

roof-mounted equipment shall be completed in accordance with Florida Building Code requirements and submitted by a structural engineer registered in the State of Florida.

PART 2 - PRODUCTS

- 2.1 MANUFACTURERS
 - A. Specified Products: Manufacturer's names and product model numbers indicated on the drawings and in these specifications establish the type, style, quality, performance, and sound rating of the desired product. Listing of other manufacturers indicates that their equivalent products would be acceptable if they meet the specification requirements, the specific use and installation shown on the drawings, including space and clearance requirements, and the energy consumption and efficiency of the specified product. The listing of additional manufacturers in no way indicates that the manufacturer can provide an acceptable product.
 - B. Space Requirements: All manufactured products furnished on this project must have the required space and service areas indicated in the manufacturer's printed literature or shown on their shop drawing. When the manufacturer does not indicate the space required for servicing the equipment, the space shown on the drawings or as required by the Architect must be provided.

2.2 MATERIAL AND EQUIPMENT

- A. General: Material and equipment used shall be produced by manufacturers regularly engaged in the production of similar items, and with a history of satisfactory use as judged by the Architect.
- B. Specified Equipment: Equipment shall be the capacity and types indicated or shall be equivalent in the opinion of the Architect. Material and equipment furnished and installed shall be new, recently manufactured, of standard first grade quality and designed for the specific purpose. Equipment and material furnished shall be the manufacturer's standard item of production unless specified or required to be modified to suit job conditions. Sizes, material, finish, dimensions and the capacities for the specified application shall be published in catalogs for national distribution. Ratings and capacities shall be certified by a recognized rating bureau. Products shall be complete with accessories, trim, finish, safety guards and other devices and details needed for a complete installation and for the intended use and effect.
- C. Compatibility: Material and equipment of one and the same kind, type or classification and used for identical or similar purposes shall be made by the same manufacturer. Where more than one choice is available, select the options which are compatible with other products already selected. Compatibility is a basic general requirement of product selection.
- D. Coordination of Materials: In the event of multiple award packages for the completion of this work, the Contractor shall direct and lead the coordination effort necessary to ensure that all materials and equipment that have moving parts, are procured from the same manufacturer and are the same model as consistent with its use and as required by these specifications.
 - 1. The Contractor shall additionally ensure that the installation of this material and equipment is consistent for the Owner's use and maintenance, and shall effect necessary adjustments to render the installations consistent.

2. In the event of dispute, the earlier award package materials, as prescribed by approved submittal documents, shall take precedent in defining the material and equipment coordination requirements of the project.

PART 3 - EXECUTION

3.1 WORKMANSHIP

- A. General: The installation of materials and equipment shall be done in a neat, workmanlike and timely manner by an adequate number of craftsmen knowledgeable of the requirements of the Contract Documents. They shall be skilled in the methods and craftsmanship needed to produce a first-quality installation. Personnel who install materials and equipment shall be qualified by training and experience to perform their assigned tasks. All materials and equipment shall be installed per the manufacturer's written requirements.
- B. Acceptable Workmanship: Acceptable workmanship is characterized by first-quality appearance and function which conforms to applicable standards of building system construction and exhibits a degree of quality and proficiency which is judged by the Architect equivalent as or better than that ordinarily produced by qualified industry tradesmen.
- C. Performance: Personnel shall not be used in the performance of the installation of material and equipment that, in the opinion of the Architect, are deemed to be careless or unqualified to perform the assigned tasks. Material and equipment installations not in compliance with the Contract Documents, or installed with substandard workmanship in the opinion of the Architect, shall be removed and reinstalled by qualified craftsmen at no change in the contract price.
- 3.2 AIR CONVEYANCE SYSTEM MECHANICAL CLEANING (New Duct Installation)
 - A. General: The following criteria shall be used for the installation of all new HVAC air conveyance systems (ACS).
 - B. Qualifications: The enhanced air conveyance system cleaning procedures shall be performed by the Contractor. Microbiological analysis shall be performed by a firm which is acceptable to the Architect and which can demonstrate their ability to conduct the required analysis and reporting according to the NADCA and National Institute for Occupational Safety and Health (NIOSH) Methods. Submit for review and acceptance by the Architect the proposed procedure methodologies to be utilized, a listing of the proposed equipment to be used, and the proposed chemical agents to be used.
 - C. Cleaning Procedure: All ductwork transported to the project shall be protected from weather and debris. Once on site, all ductwork shall be stored via an elevated structure above a finished floor slab and covered with plastic to protect from construction debris. Each HVAC duct section shall, prior to installation, be cleaned and disinfected. Exhaust ductwork shall only require surface preparation from Note 1 below. All air distribution devices (diffusers, grilles, registers) including backpans of supply devices in critical areas, as defined by AIA, shall be decontaminated pursuant to Note 3 below. Four stages of ACS cleaning shall occur:
 - 1. Surface dirt shall be removed by mechanical means, HEPA filtered vacuum and washed down with disposable cleaning cloths and 1:200 solution of trisodium phosphate (TSP) detergent.

- 2. Wipe down surface with TSP solution again, frequently disposing contaminated cloths.
- 3. Decontaminate duct section with a diluted solution (4-6 tablespoons per gallon or as directed by manufacturer for use) of chlorhexidine diacetate, similar to Aveco Company Nolvasan, for an appropriate contact period then wipe down and rinse with clean cloths per the application processes defined by manufacturer guidelines.
- 4. Cap ducts with a 6 mil. plastic fastened completely to duct openings.
- D. Sterilization, Occupied Facility: After the ACS has been cleaned and installed, provide surface sampling shall be performed by firm to confirm absence of Aspergillis fumigatus. Upon installation of a zone, the entire ACS shall then be flooded with Bioclean, or another low-odor dual quaternary ammonium compound, EPA registered for use in HVAC systems, and acceptable to the Architect, to sterilize the ACS. The ACS shall be tested in compliance with NADCA Level III sampling protocol until all air samples indicate a colony forming unit (CFU) count of 1.0 CFU per cubic meter or less; re-clean, resterilize and retest until all samples achieve results at or below this threshold level.
- E. Reporting: Provide a complete report detailing the above processes. The report shall contain, as a minimum, the procedure methodologies utilized; the listing of the equipment used; a description of the portions of the ACS which were treated; the chemical agents which were used; the test results from the analysis.

3.3 CLEANING AND PROTECTION

- A. General: Refer to Division 1.
- B. Emergency Contacts: Prior to the beginning of the project, provide the Owner with a list of names, emergency telephone and beeper numbers of individuals who can be contacted during working and non-working hours, including weekends, for assistance throughout the warranty period if leaks, equipment failure or other damages occur. Update the list throughout installation and warranty to provide continuous availability of responsible parties to the Owner. If the Owner cannot contact the responsible party during an emergency situation, the Owner may affect emergency repairs through other means and may backcharge for the costs of repair material and labor incurred.
- C. Emergency Contacts: Along with the operating and maintenance manual submittal, provide the Owner with a list of the names and emergency telephone and beeper numbers of individuals who can be contacted during working and non-working hours, including weekends, for assistance throughout the warranty period should leaks, equipment failure or other damage occur. Update the list throughout warranty to provide continuous availability of responsible parties to the Owner. If the Owner cannot contact the responsible party during an emergency situation, the Owner may affect emergency repairs through other means and may backcharge for the costs of repair material and labor incurred.
- D. Housekeeping: Keep interiors of duct and pipe systems clean and free from dirt, rubbish and foreign matter. Close open ends of piping and ductwork at all times throughout the installation. Install 30% efficient filter media over each return air grille and open return duct opening; change media regularly during construction when dirty to keep duct interiors clean. Prevent dust, debris and foreign material from entering the piping and ductwork.

- E. Equipment Protection: Protect fan motors, switches, equipment, fixtures, and other items from dirt, rubbish and foreign matter. Do not operate air-handling equipment if the building is not clean or if dust can enter the coils or the fan housings.
- F. Equipment Cleaning: Thoroughly clean equipment and entire piping systems internally upon completion of installation and immediately prior to final acceptance. Open dirt pockets and strainers, blow down each piping system and clean strainer screens of accumulated debris. Remove accumulated dirt, scale, oil and foreign substances. Thoroughly wipe clean internal surfaces of ductwork and air handling units prior to request for substantial completion. (See para. 3.2 above.)
- G. Building Cleanup: Remove debris, rubbish, leftover materials, tools and equipment from work areas and site. Clean tunnels and closed off spaces of packing boxes, wood frame members and other waste materials used in the installation. Final acceptance shall not be approved until site is cleaned.
- H. Fixture Cleanup: Remove temporary labels, stickers, etc., from fixtures and equipment. Do not remove permanent nameplates, equipment model numbers, ratings, etc.
- I. Filter Replacement: Provide filters, with the same efficiency rating as required for the final installation, for the protection of the air moving equipment and ductwork continuously throughout the construction phase. Provide a new set of clean filters for the test and balance of the air side equipment.
- J. Protection of Finished Installation: Where installation is required in areas previously finished by other trades, protect the area from marring, soiling or other damage.
- K. Air Handling Unit Operation During Construction Phase: Do not operate air handling equipment during building construction phase unless filter fabric is fastened to all duct systems' inlets and all specified and scheduled air filters are installed to minimize dirt entry into ductwork and air moving equipment. When running air handling units to dry out the building, control the building temperature to drop very slowly, and verify all HVAC insulation is completed and doors and windows are installed and closed, to prevent condensation of water from humid air on building interior surfaces, equipment, materials and ductwork.

3.4 CORRECTION OF WORK

- A. General: At no additional cost to the Owner, rectify discrepancies between the actual installation and contract documents when in the opinion of the T&B Agency or the Architect the discrepancies will affect system balance and performance.
- B. Drive Changes: Include the cost of all pulley, belt, and drive changes, as well as balancing dampers, valves and fittings, and access panels to achieve proper system balance recommended by the T&B Agency.

3.5 COORDINATION AND ASSISTANCE

A. General: Provide all labor, equipment, tools and material required to operate the equipment and systems necessary for the testing and balancing of the systems and for the adjustment, calibration or repair of all electric or pneumatic automated control devices and components. These services shall be available on each working day during the period of final testing and balancing.

- B. Drawings and Specifications: Provide to the T&B Agency a complete set of project record drawings and specifications and an approved copy of all HVAC shop drawings and equipment submittals. The T&B Agency shall be informed of all changes made to the system during construction, including applicable change orders.
- C. Coordination: Coordinate the work of all trades and equipment suppliers to complete the modifications recommended by the T&B Agency and accepted by the Architect. Cut or drill holes for the insertion of air measuring devices as directed for test purposes; repair to as-new condition, inserting plastic caps or covers to prevent air leakage. Repair or replace insulation and re-establish the integrity of the vapor retardant.

3.6 PREPARATIONS FOR PERFORMANCE VERIFICATION

- A. Verification: Prior to commencement of the balancing by the T&B Agency, the Contractor shall verify in writing:
 - 1. That air filters have been replaced and are in clean condition.
 - 2. That linkages between dampers and their actuators are secure, non-overloading and non-binding.
 - 3. That ductwork specialties are in their normal operating positions.
 - 4. That fans are operating at the correct rotation and specified RPM.
 - 5. That ductwork has been pressure tested and accepted.
 - 6. That strainers have been removed, cleaned and replaced, and that temporary construction strainers have been removed.
 - 7. That compression or expansion tanks have been inspected, are not air-bound or water-logged and are pre-charged, and that the piping systems have been completely vented and filled with water.
 - 8. That air vents at coils and high points of the piping systems have been inspected and installed and operating freely.
 - 9. That automatic valves, hand valves, and balancing valves have been placed in a fixed open position for full flow through all devices.
 - 10. That linkages between valves and their actuators are secure, non-overloading and non-binding.
 - 11. That pressures for hydronic reducing valves have been set.
 - 12. That operating temperatures have been set for chillers, regulating valves, etc.
 - 13. That pumps are operating at the correct rotation and specified horsepower.
 - 14. That piping has been pressure tested and accepted and piping systems have been cleaned, flushed, sterilized and refilled with chemicals and prescribed treated water and vented.
 - 15. That operating temperatures have been set for boilers, regulating valves, etc.
 - 16. That the operating safeties (thermal overloads, firestat/freezestats, smoke detectors, relief valves, etc.), are installed and fully functional.
 - 17. That equipment has been lubricated and can be operated without damage.
 - 18. That the systems are operational and complete.
 - 19. That no latent residual work remains to be completed.

3.7 ACCEPTANCE TESTING PROCEDURE

A. General: Each HVAC system shall be tested to confirm proper operation and function in accordance with the construction documents and control sequence of operations.

- B. The enclosed checklists shall be completed for each system and signed off by the mechanical sub-contractor project representative, then verified and signed-off by the mechanical sub-contractor project supervisor and the construction manager systems engineer. All checklists shall be incorporated into the project's close-out manuals submitted for Owner record.
- C. On-site testing by the Architect and Engineer shall be performed at the discretion of the Architect/Engineer for any or all systems to confirm test results and system function.
- D. The Contractor is responsible to provide adequate time in the completion of the construction to perform these system tests prior to the AHCA final inspections in the affected areas/systems.
- E. The Contractor is responsible for ensuring all required system tests are conducted successfully and recording associated test data and results.
- F. The Contractor is responsible for contacting the Architect and Engineer at least two weeks prior to system test availability and schedule acceptable to Architect/Engineer for on-site testing.
- G. If, in the Architect's and Engineer's opinion, the test results indicate that the systems' installation is not adequately complete for testing, the testing shall be re-scheduled and the Contractor shall be responsible to prepare for such re-test.
- H. Prior to Owner occupancy, all system testing shall be completed and approved.

3.8 PROTECTION OF MATERIALS AND EQUIPMENT

- A. Requirements: Do not store fiberglass insulation or any equipment within the building until it has been "dried in". If dry space is unavailable and the insulation and equipment must be installed or stored before the building is "dried in" and completely enclosed, provide polyethylene film cover for protection.
- B. Replacement of Damaged Stored Material and Equipment: Any material and equipment that has been wet or otherwise damaged prior to installation, in the opinion of the Architect, shall be replaced with new material regardless of the condition of the material and equipment at the time of installation.
- C. Repair of Damaged Installed Material and Equipment: After installation correct or repair dents, scratches and other visible blemishes. At the direction of Architect replace or repair to "as new" condition equipment which has been damaged during construction.
- D. During construction, all piping and ductwork system openings shall be capped with at least two layers of polyethylene film, fastened tightly in place with banding material or foil tape until connection of the continuation of such piping or ductwork is occurring.
- E. All air diffusers serving critical care areas shall be disinfected per owner infection control guidelines with a commercial germicide complying with EPA regulations utilizing per manufacturer use standards prior to building occupancy.

3.9 COORDINATION OF SERVICES

- A. General: Where phasing of the work requires partial occupancy, coordinate interruption of services to Owner-occupied areas in writing in advance with the Architect. Shutdown time and duration of services interruption shall be decided by the Owner. Provide shutoff valves at points of interconnection to minimize downtime. Procedures incidental to the outage shall be prepared in advance to minimize downtime.
- B. General: Coordinate interruption of services in writing at least 1 week in advance with the Architect. Shutdown time and duration of services interruption shall be decided by the Owner. Provide shutoff valves at points of interconnection to minimize downtime. Procedures incidental to the outage shall be prepared in advance to minimize downtime.
- C. Protection of Facilities: Portions of the building may be operational during construction. Maintain operation of the equipment and systems whenever the installation interfaces with equipment or systems. Provide protection for the building, its contents and occupants wherever installation under the contract is performed. As necessary, move, store, and protect furniture, office fixtures and carpets. Provide acoustical isolation of the work area with temporary doors, partitions, etc., to allow normal work functions. Provide exhaust fans, temporary dust barrier partitions and any containment measures required to prevent dirt, dust or fumes from reaching adjacent occupied spaces as required by the Owner or Architect. Access to the building, including exit stairs, doors and passageways, and loading dock and other delivery areas shall be kept open and continuously accessible to the occupants. Workmen shall be confined to those areas directly involved in the project installation, and only during time periods indicated and approved by the Owner.

3.10 PAINTING OF PIPING AND DUCTWORK

- A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual".
 - 1. Use applicators and techniques suited for paint and substrate indicated.
 - 2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 - 3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
 - 4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating or nomenclature plates.
 - 5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple costs of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional costs until cured file has a uniform paint finish, color, and appearance.
- A. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness or other surface imperfections. Cut in sharp lines and color breaks.

- B. Painting of Fire Protection work:
 - 1. Paint the following work where exposed in Equipment Rooms:
 - a. Uninsulated metal piping.
 - b. Uninsulated plastic piping.
 - c. Pipe hangers and supports.
 - d. Tanks that do not have factory applied final finishes.
 - e. Duct, equipment and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
 - 2. Paint the following work where exposed in Occupied Spaces:
 - Equipment, including panelboards.
 - Uninsulated metal piping.
 - Uninsulated plastic piping.
 - Pipe hangers and supports.
 - Duct, equipment and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
 - 3. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.11 FIELD QUALITY CONTROL

- A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.
- B. Contractor shall touch up and restore painted surfaces damaged by testing.
- C. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.13 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

END OF DOCUMENT 23 0100

ACCEPTANCE TESTING CHECKLIST		
A. AIR HANDLING UNIT #	ок	N/A
FANS AND CASING SECTIONS:		
1. Spring isolators installed and not bottomed out.		
2. Motor rotation correct and free fan wheel rotation.		
3. Motor belts aligned and properly tensioned.		
4. Proper starter/VFD installed and labeled.		
5. Bearing races secured tight to fan shaft.		
6. Bearing grease cert fitting accessible and lubricated.		
7. All bolts, fasteners, and set screws checked & tightened.		
8. At full speed, fans have no unusual noise or vibration.		
9. All safety guards are properly installed.		
10. Access doors close tightly, door gaskets installed.		
11. Casing/duct sealed with proper sealant.		
12. Proper insulation installed on casing and duct, and joints sealed.		
13. No evidence of air escaping unit or insulation ballooning w/fans on.		
14. No evidence of negative machine room pressure with fans operating.		
15. Fan air volume measuring device installed.		
16. Duct static pressure control sensor installed at proper location.		
17. Duct safety static pressure sensor installed at proper location.		
18. Flex connection at fan discharge installed.		
19. Condensate drain trapped properly and run to floor drain.		
20. Manufacturer's required clearances for unit/components maintained.		
21. Dampers/actuators properly installed & close tightly.		
22. Damper linkage checked for binding, min. play & right blades.		
23. Required maintenance clearances maintained.		
24. Filters installed tightly and checked for no bypass.		
25. Metal spacers installed in filter rack.		
26. Filter manometers installed and calibrated.		
27. Air Handler control system operational.		
CHILLED WATER COILS:		
1. Colls clean and fins in good condition.		
2. No open area around coil for air bypass.		
3. Coll piped for counter flow.		
4 Chilled water pipe complete and piping property supported.		
Chilled water pipe is properly insulated and labeled. Chilled water pipe pressure test complete and no looks		
6. Chilled water pipe pressure test complete and no leaks.		
All Dieed Valves Will Gaps Installed. Strainara, drain valva, basa bib and can installed		
o. Strainers, urain valve, nose bib and cap installed.		
Directions a caps installed. Directions a caps installed. Directions a caps installed.		
o. riping, valves, and diediances accommodate comremoval.		
3. Datatue valve property installed.		
To. Control valves propeny installed.		

11. Pilot positioner installed on control valve actuator.	
11. Thermometers, PT plugs, pressure gages properly installed.	
12. Condensate pan, drain, and trap drains condensate properly.	
HEATING HOT WATER COILS:	
1. Coils clean and fins in good condition.	
2. Hot water pipe is complete and properly supported.	
3. Thermometers, PT plugs, pressure gages properly installed.	
4. Control valve installed if coil is w/o integral face & bypass dampers	
5. Two position valve installed if coil has integral face & bypass dampers	
6. Piping, valves, and clearances accommodate coil removal.	
7. Local in-line coil circulating pump installed & operable.	
8. Strainer, drain valve, hose bib and cap installed.	
9. Air bleed valves with caps installed.	

Air Handing Unit Comments:

Approvals:

_____Date____ Mech. Contractor Signature _____Date____ GC PM/Sys. Engineer Signature

CHILLER #	OK	Ν/Δ
	OR	
1. Isolation valves installed.	1	
2. Pipes properly supported & not supported by chiller.		
3. Refrigerant relief vented outside and rain protected.		
4. Relief piping weight not bearing on rupture disc.		
5. Adequate space for tube pull.		
6. Unit has proper insulation type and thickness.		
7. Piping and insulation is complete and undamaged.		
8. Flow direction is indicated correctly on chilled and condenser water lines.		
9. Insulation is installed where condensation may occur.		
10. Pressure gages are installed across evaporator and condenser.		
11. Thermometers are installed across evaporator and condenser.		
12. Evaporator and condenser heads removed, inspected, & trash free.		
13. Vibration isolation pads installed.		
14. Differential pressure type flow switches are installed.		
15. Drain valves piped to floor drain.		
16. Control wells installed.		
17. Oil cooler piped.		
18. Clearances have been maintained and piping is installed for service.		
19. Chilled and Condenser water connections to chiller are correct.		
20. Chilled & condenser pumps are interlocked to chiller in auto mode.		
21. CT fans enabled when chiller is in auto mode.		
22. Factory representative start-up completed and documented.		
23. PT plugs are installed at entering & leaving evap & cond connections.		

Chiller Comments:

Approvals:

___Date___

Mech. Contractor Signature

GC PM/Sys. Engineer Signature

COOLING TOWER #	ок	N/A
1. Basin is clean & filled.		
2. Cooling tower piped correctly.		
3. Ladder installed per OSHA.		
4. Overflow piped to drain.		
5. Makeup to tower does not exceed 25 psi for float.		
6. Makeup to tower does not exceed 50 psi for solenoid.		
7. Makeup water metered with meter type and location req'd by utility.		
8. Pipes are supported and labeled correctly.		
9. Makeup water shut off valve installed and open.		
10. Chemical treatment system installed correctly.		
11. Fan guards are installed and tight.		
12. Basin heater installed and operable.		
13. Outdoor lines are heat traced.		
14. Basin height above inlet of pumps is correct.		
15. Condenser water lines to pumps are not elevated above basin/sump.		
16. Motor rotation correct.		
17. Fan blade checked for free clearance.		
18. Bearings lubricated on fans and shaft.		
19. Belt properly installed and protected.		
20. Gear box lubricated.		
21. Vibration safety switch checked for operation.		
22. Heat tape properly installed.		

Cooling Tower Comments:

Approvals:

____Date____

Mech. Contractor Signature

GC PM/Sys. Engineer Signature

BOILER #	OK	N/A
1 Unit is level		
2 All holts are tight		
3 Clearance for maintenance and tube pull verified		
4 Gas line connected		
5 Gas pressure correct for burner		
6. Gas pilot connected with ability to function when running on oil.		
7. Gas vents are installed correctly.		
8. Relief valves are correctly installed.		
9. Flue stack installed and complete with thermometer mounted.		
10. Verify external pipe connections are to the correct boiler opening.		
11. Verify PRV's are at the correct settings.		
12. Boiler feed piped with SCH 80 pipe and heavy duty fittings.		
13. Boiler feed check valves installed correctly.		
14. Quick fill installed, pressure correct, and back flow preventor in place		
15. Verify boiler has been boiled out properly.		
16. Boiler blow down valves installed.		
17. Boiler blow down piping correct type.		
18. Blow down receiver/cooler installed correctly.		
19. Blow down receiver installed.		
20. Surface blow down installed.		
21. Boiler water sampler installed.		
22. Chain valve operators installed.		
23. Flue drain installed.		
24. Oil lines connected.		
25. Oil filter installed on boiler, one per boiler.		
26. Chemical feed installed correctly		
27. Water softener supply to feed system installed & softeners operating.		
28. Factory representative start-up completed & documented.		

Boiler Comments:

Approvals:

_____Date_____ Mech. Contractor Signature _____Date____ GC PM/Sys. Engineer Signature

CV TERMINAL BOX #	PART K	N/A
1. At least 1 & 1/2 box inlet diameter of hard duct attached to box inlet.		
2. Run out from lateral is the correct size.		
3. Required clearance for servicing box.		
4. Correct piping package for reheat coil.		
5. Hot water return off top of coil.		
6. Electrical connections complete.		
7. Box properly located and supported.		

Terminal Box Comments: _____

Approvals:

_Date____ Mech. Contractor Signature

_____Date____ GC PM/Sys. Engineer Signature

CHWCWHHW PUMP #	ок	N/A
1. Pressure gauge connection at pump inlet & outlet flanges.		
2. Single pressure gauge installed with cocks to select in or our		
pressure.		
3. Rotation correct.		
4. Strainer w/valve, hose bib and cap installed.		
5. Piping supported so that pump bears no pipe weight or lateral force.		
6. Drains piped to floor drain.		
7. Motor and pump coupling alignment verified.		
8. Cleanout of system piping complete.		
9. Suction diffuser start up strainer has been replaced w/ permanent strainer.		
10. Pumps properly grouted.		
11. Expansion tank connected to suction side of pump.		
12. Makeup water PRV set at correct pressure.		
13. VFD's installed.		

Pump Comments:

Approvals:

_____Date____ Mech. Contractor Signature _____Date____ GC PM/Sys. Engineer Signature

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

REQUEST FOR SUBSTITUTION

Project Name:		Location:		-
Date of Request:				
Name of Party Reques	ting Substitute:			
Reason for Substitutior	ı Request:			-
Drawing	Spec. Sect. No.	Paragraph	Specified Item	-
Proposed Substitute: _				
Manufacturer and Mode	el Number:			
Deviations from the Sp	ecified Item: (See par	ragraph entitled "[Deviations".)	-
Reason for Substitutior	1:			
Changes to Other Systems to Permit Use of Proposed Substitute: (List changes. Submit drawings if required for clarity.)				
Technical Data to Support Request for Acceptance: (List ASTM or other standards designations, testing laboratory reports, experience records, etc.)				

Other Supporting Data: (Submit brochures, samples, drawings, etc.)

REQUEST FOR SUBSTITUTION (Continued)

<u>Certification</u>: In making request for substitution, the party whose authorized signature appears below, certifies that all of the following statements are correct and are accepted without exception:

The proposed substitution has been personally investigated and is equal or superior in all significant respects to the product specified for the specific applications required;

The proposed substitution will be warranted under the same terms required for the specified product;

Coordination aspects necessitated by the proposed substitution will be accomplished in a complete and proper fashion by the party signing this form without any additional cost to the Owner; and

Claims against the Owner for additional costs related to the proposed substitution which subsequently become apparent after acceptance by the Architect are hereby waived.

<u>Credit:</u> If this substitution is acceptable the following credit shall be given to the Owner;

CERTIFICATION OF EQUIVALENT PERFORMANCE AND ASSUMPTION OF LIABILITY FOR EQUIVALENT PERFORMANCE

The undersigned states that the function, appearance and quality are equivalent or superior to the specified item.

Submitted by:

Signature

Title

\$___

Typed Name:

Company:

Signature shall be by person having authority to legally bind his firm to the above terms. Failure to provide a legally binding signature will invalidate this request.

SECTION 23 0500 COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Dielectric fittings.
 - 3. Mechanical sleeve seals.
 - 4. Sleeves.
 - 5. Escutcheons.
 - 6. Grout.
 - 7. Equipment installation requirements common to equipment sections.
 - 8. Painting and finishing.
 - 9. Concrete bases.
 - 10. Supports and anchorages.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:
 - 1. CPVC: Chlorinated polyvinyl chloride plastic.
 - 2. PVC: Polyvinyl chloride plastic.
- G. The following are industry abbreviations for rubber materials:
 - 1. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Dielectric fittings.
 - 2. Mechanical sleeve seals.
 - 3. Escutcheons.
- B. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

- A. Refer to individual Division 23 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 - 2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and fullface or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for generalduty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- H. Solvent Cements for Joining Plastic Piping:
 - 1. CPVC Piping: ASTM F 493.
 - 2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

2.4 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
 - 1. Manufacturers:
 - a. Epco Sales, Inc.
 - b. Watts Industries, Inc.; Water Products Div.
 - c. Zurn Industries, Inc.; Wilkins Div.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
 - 1. Manufacturers:
 - a. Capitol Manufacturing Co.
 - b. Epco Sales, Inc.
 - c. Watts Industries, Inc.; Water Products Div.
- E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
 - 1. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Central Plastics Company.
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.
- F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
 - 1. Manufacturers:
 - a. Calpico, Inc.
 - b. Lochinvar Corp.
- G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.
 - 1. Manufacturers:
 - a. Perfection Corp.
 - b. Precision Plumbing Products, Inc.

- c. Sioux Chief Manufacturing Co., Inc.
- d. Victaulic Co. of America.

2.5 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
 - 1. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 3. Pressure Plates: Plastic. Include two for each sealing element.
 - 4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.6 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with set screws.

2.7 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chromeplated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
 - 1. Finish: Rough brass.
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
 - 1. Finish: Rough brass.

- E. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.
- F. Split-Plate, Stamped-Steel Type: With exposed-rivet hinge and chrome-plated finish.

2.8 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

- 1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stampedsteel type and set screw.
- M. Sleeves are not required for core-drilled holes.
- N. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
 - 3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
 - b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
 - c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
 - 1) Seal space outside of sleeve fittings with grout.
 - 4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
- O. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 - 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.

- 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- P. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- Q. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
- R. Verify final equipment locations for roughing-in.
- S. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
 - 3. PVC Nonpressure Piping: Join according to ASTM D 2855.

3.3 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
 - 3. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.5 PAINTING

- A. Painting of HVAC systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.6 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions.
 - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.

- 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
- 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
- 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
- 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
- 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
- 7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 5 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.8 GROUTING

- A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF DOCUMENT 23 0500

SECTION 23 0513 COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.
- B. Comply with NEMA MG 1 unless otherwise indicated.

2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Energy efficient, as defined in NEMA MG 1, and in accordance with ASHRAE/IESNA 90.1.
- C. Service Factor: 1.15.

- D. Enclosure Type: Totally enclosed fan cooled for all cooling tower motors, air handling units, exhaust fans and pumps.
- E. Rotor: Random-wound, squirrel cage.
- F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- G. Temperature Rise: Match insulation rating.
- H. Insulation: Class F.
- I. Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Drives: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
 - 2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation, in accordance with NEMA MG 1 Paragraph 31 requirements for use with Inverters.
 - 4. Thermal Protection: Comply with NEMA MG 1, Part 3, requirements for thermally protected motors.

2.5 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
 - 2. Capacitor start, inductor run.
 - 3. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF DOCUMENT 23 0513
SECTION 23 0515 VARIABLE FREQUENCY DRIVES

PART1- GENERAL

1.1 RELATED DOCUMENTS

A. Basic Requirements: Provisions of Section 23 0100, BASIC MECHANICAL REQUIREMENTS are part of this Section.

1.2 SUMMARY

- A. General: Provide Variable Frequency Drives of the latest design and technology to provide adjustable frequency/speed control of motors, as indicated herein and on the Construction Documents. It is the intention of these specifications that the VFD controller shall be completely solid-state variable voltage source design.
- B. Chiller Controllers: This section specifically does not include variable frequency or speed controllers for Chillers.

1.3 QUALITY ASSURANCE

- A. Single Manufacturer: All VFD units shall be provided by a single manufacturer.
- B. Parts and Service: The VFD Manufacturer shall maintain, as part of a national network, Engineering and Parts service facilities to provide start-up service, emergency service calls, repair work, service contracts, maintenance and training of customer personnel.
- C. Standards: The VFD shall comply with latest IEEE 519 "Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems", and the latest applicable standards of ANSI, NEMA and the NEC. As a minimum, the full load output current rating of the drive shall be equal to 1.2 times the equivalent motor horsepower full load current (as listed by National Electric Code Table 430-150).
- D. Harmonics: The VFD's shall limit harmonic distortion reflected onto the source distribution system to a voltage and current distortion level as defined by IEEE 519.
 Harmonic calculations shall be provided with submittal. Field testing and certification is required as indicated separately in this specification.

1.4 SUBMITTALS

- A. General: Submittals shall be provided for all equipment herein specified including all data concerning dimensions, materials, efficiencies, installation instructions, wiring diagrams, UL data, and appropriate identification. Submittal shall include, but not be limited to, the following:
 - 1. Catalog cut sheet of each VFD being provided
 - 2. Dimension of each VFD
 - 3. Detailed documentation of protection devices (fuses, breakers, ground fault protection, harmonic suppression, surge suppression)
 - 4. Factory Test Information
 - 5. Information on bypass switch operation and manual starter information

Project No. 121505 Variable Frequency Drives Section 23 0515 - 1

- 6. Short circuit withstand rating of entire VFD assembly (drive and bypass), including UL testing information/data
- 7. UL Listing / UL File Number
- 8. IEEE 519 Calculations, provided by the VFD manufacturer, indicating calculated harmonic distortion levels with equipment being provided. Point of common coupling shall be at the secondary of the unit substation's transformer. Typical (unit substation's tie breaker open) and worst case (unit substation's tie breaker closed) calculations must be performed, both cases must pass voltage and current distortion limits. Note since this is a hospital and can be powered by onsite generation equipment, the most stringent distortion limits apply.
- 9. Warranty Information
- B. General: Refer to paragraph entitled "SUBMITTAL" in Division 23010. Include the following material and performance data:
 - 1. Manufacturers Literature:
 - a. Complete technical information on the Variable Frequency Drives and all specified options, indicating all cabinet dimensions and space requirements for the VFD, including bypass contactors and line reactors.
 - b. Wiring diagram with all control and power wiring for the Variable Frequency Drives Unit.
 - 2. Performance Data:
 - a. Complete efficiency versus load and speed data for all VFD ratings showing that the VFD with line reactors is capable of providing full motor nameplate rated horsepower.
 - 3. Installation Instructions:
 - a. Manufacturer's printed installation instructions including copies shipped with the equipment.
 - b. Manufacturer's instructions for the installation and checkout procedure for the Variable Frequency Drives unit.
 - 4. Maintenance Instructions:
 - a. Manufacturer's printed instructions for the maintenance of the Variable Frequency Drives unit.
 - 5. Manufacturer's Start-Up, Checkout and Instructions:
 - a. Start-up and checkout of the Variable Frequency Drives unit.
- C. Approval: VFDs shall not be ordered until submittals have been approved by the Architect and shall bear the submittal approval stamp.

1.5 STORAGE AND HANDLING

- A. Sealing: Openings shall be sealed for shipping and remain so until installation.
- B. Handling: The equipment shall be carefully handled, not subjected to shock, and protected from weather, dust, construction materials and damage.

1.6 FACTORY TESTING AND CALCULATIONS

- A. Factory Testing and Warranty: Each VFD shall be factory tested to ensure reliability. Testing shall include component thermal cycling, logic system simulation tests and full load operation tests. The VFD shall be full load heat tested at 104 degrees F ambient. for a period not less than 4 hours with no component damage. The VFD shall be furnished with manufacturer's written certification of tests conducted and their results.
- B. Efficiency Rating: Complete efficiency versus load and speed data for all VFD settings shall be submitted from factory testing and shall be no less than 95 percent at 100 percent speed and 87 percent at 60 percent speed. The VFD's shall maintain the line side displacement power factor no less than 0.95 regardless of speed and load.
- C. Motor Lead Length: It shall be the responsibility of the VFD manufacturer to determine if output filters are required based on motor lead lengths. Harmonic filters shall be provided as needed to achieve the maximum harmonic distortion levels specified herein.
- D. Point of Common Coupling: Field testing of each VFD at the point of common coupling is required to determine harmonic feedback onto the distribution system. The harmonic distortion at this point shall be limited to the voltage and current levels defined by IEEE-519 as outlined below, for "General System" applications. The total accumulation of harmonic distortion of all drives shall be calculated. A written and sealed report is to be issued by a Registered Engineer at the conclusion of the tests and if the equipment as installed has been found not to be in compliance with IEEE-519, the VFD's shall be removed at the supplier's expense and promptly replaced with conforming equipment for which testing procedure shall be repeated and documented in the same manner, all without additional cost to Owner.
- E. Allowable Distortion Limits: Total at point of verification for Project for all assemblies:
 - Voltage: 3% = 100 x <u>Total Harmonic Voltage</u> (total units) Fundamental Voltage
 - 2. Notch depth and notch volt microseconds as defined by the latest edition of IEEE 519 Standard.
 - 3. Maximum harmonic current distortion in percent of fundamental shall be per IEEE 519 for specific count pulse unit
 - 4. Use of isolation and active filter devices (per Section 26 3215) is assumed by this specification, as required to obtain specified performance.
 - 5. Harmonic calculations shall be based on the kVA capacity and impedance of the transformer supplying the equipment power voltage. The Contractor shall supply this information to the VFD Manufacturer and active harmonic filter manufacturer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

1.

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 121505 Variable Frequency Drives Section 23 0515 - 3

- A. Manufacturers: The VFD shall be as produced by one of the following manufacturers. Other manufacturers are not acceptable and will not be considered.
 - 1. ABB
 - 2. Danfoss/Trane
 - 3. York International
 - 4. Yaskawa
- B. Requirements: VFD manufacturers listed here are not automatically approved for this project. All requirements of these specifications must be fully met for the VFD to be approved.

2.2 VARIABLE FREQUENCY DRIVE

- A. General: The Variable Frequency Drive shall be capable of converting the input voltage to variable frequency, three phase AC power for variable torque motor control continuously from 10 percent to 100 percent of base speed. A transformer shall not be used to adjust the input or output voltage. All general options and modifications shall mount within the VFD enclosure. The voltage-to-frequency ratio shall be automatically adjusted to maximize energy savings.
- B. Duty: The adjustable frequency system shall be continuous centrifugal duty stepless VFD matched to the motors provided with the equipment (i.e. fans and pumps). The VFD's shall be capable of operating any motor, regardless of manufacturer, with a load rating within the capacity of the VFD's.
- C. Microprocessor Based: The VFD's shall provide a microprocessor-based adjustment of three-phase motors.
- D. Pulse: The VFD's shall be of the 12 pulse for motor HP <100, Pulse Width Modulated (PWM) design converting the utility input voltage and frequency to a variable voltage and frequency output via a two-step operation. VFD's utilizing a third power section are not acceptable.
- E. Operating Conditions: Standard operating conditions shall be:
 - 1. Incoming Power: Specified Voltage +5% to -10% and 60 hertz +/-2 hertz power to a fixed potential DC bus level.
 - 2. Humidity: 0 to 95% non-condensing and non-corrosive (indoor applications).
 - 3. Altitude: 0 to 3,300 feet above sea level.
 - 4. Ambient Temperature: 0 to 40 degrees C (indoor applications).
- F. Rotating Motor: The VFD's shall be able to start into a spinning motor. The VFD's shall be able to determine the motor speed in any direction and resume operation without tripping. If the motor is spinning in the reverse direction, the VFD's shall start into the motor in the reverse direction, bring the motor to a controlled stop, and then accelerate the motor in the preset method of starting.
- G. Housing: VFD's located in dry interior spaces shall be housed in a NEMA 1 enclosure; VFDs located outside or in damp locations shall be provided with NEMA 3R weatherproof enclosure.

- H. Power Factor: Power Factor Correction capacitors shall not be utilized to meet motor performance criteria.
- I. Front Door: The front door of the controller shall include a door interlock disconnect switch. This shall prevent opening of the unit until the disconnect is in off position. Input fuses shall be provided.
- J. Manual Reset: The output power circuitry of the unit shall include a manual reset motor overload relay interlocked with the "on" circuitry of the unit. This shall be an adjustable solid-state device to allow easy field adjustment to motor nameplate amps.
- K. Minimum Withstand Rating: The entire Variable Frequency Drives assembly (drive, bypass and all components) shall be capable of a minimum withstand rating of 65,000 AIC or as indicated on the electrical drawings, for a minimum 3-cycles. The VFD assembly nameplate shall indicate that the entire assembly (not individual components) is rated at this minimum withstand rating. Test data indicating that the entire assembly has been tested to this rating shall be submitted to the Engineer for review.
- L. UL Listing: The entire Variable Frequency Drives assembly (drive, bypass and all components) shall be UL-listed as a single assembly. Individual component listings only shall not be acceptable. UL test data indicating that the entire assembly has been tested and approved by UL shall be submitted to the Engineer for review.
- M. Line Reactor: Provide 3 phase AC line reactor of minimally 3% impedance as integral components for each VFD.

2.3 CONTROL AND MONITORING FUNCTIONS

- A. General: All VFD's programmable parameters shall be adjustable from a digital operator keypad located on the front door of the VFD or equivalent, convenient arrangement without opening the front door. Parameters shall include:
 - 1. Programmable maximum and minimum frequency.
 - 2. Programmable acceleration and deceleration times.
 - 3. Selectable carrier frequencies, V/Hz, and critical frequency avoidance lockout.
 - 4. Adjustable electronic overload and torque limits.
 - 5. Multiple attempt restart.
 - 6. Keypad lockout and factory default overrides.
- B. Display: The VFD's shall have a minimum of 8 character display indicating monitored functions as described in the preceding paragraph. The following parameters shall be monitored:
 - 1. Input current, RMS (3 phases)
 - 2. Input voltage, RMS (3 phases)
 - 3. Output current, RMS (3 phases)
 - 4. Output voltage, RMS (3 phases)
 - 5. Output frequency
 - 6. Kilowatts (input and output)
 - 7. Drive temperature
 - 8. Time
 - 9. Date
 - 10. Elapsed time meter

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 121505 Variable Frequency Drives Section 23 0515 - 5

- 11. Motor rpm
- C. Additional Features: The VFD's shall be additionally equipped with a digital operator station mounted on the enclosure. Control operator devices and indication lights shall include:
 - 1. Digital speed control.
 - 2. Hand-Off-Auto control selector switch.
 - 3. LED status lights for HOA position.
 - 4. Local remote speed control selector switch.
 - 5. LED status lights for local remote switch position.
 - 6. LED status lights for run, fault, alarm, up-to-speed, and drive-ready status.
- D. Interface: The VFD's shall include the following system interfaces:
 - 1. Two (2) isolated process control speed reference interfaces to receive and isolate 0-10 Vdc or 4-20 mAdc signals.
 - 2. One (1) analog output signal 0-10 Vdc for external metering.
 - 3. One (1) analog output signal 4-20mA for external metering.
 - 4. Run relay with an isolated set of form C contacts.
 - 5. Dedicated terminal blocks for interface with remote start contact and remote safety trips.
 - 6. 120 VAC control to allow VFD's to interface with remote contacts at a distance up to 500 feet and with three wire control.
 - 7. Unit mounted display indicating monitored and drive diagnostic information in English language. Coded messages are not acceptable.
 - 8. Dry contact output to indicate protective function trip.
 - 9. A 0 to 5 volt DC signal shall be provided for future use. A 4-20mA signal shall be provided for interface to controls system. The signals shall vary in direct proportion to the controller speed.
 - 10. The unit shall have a dedicated terminal block to allow the controller to be interconnected with external shutdown contacts, such as a smoke detector, fire detector, or time clock. If the unit is shut down by a remote alarm circuit (not including the time clock), a door mounted "external fault" light shall light.
 - 11. Standard Digital interface to the Building Control System in Section 23 0900, in one of the following:
 - BACNet MS/TP
 - Modbus
- E. H-O-A Switch: The front door of the unit shall have a "hand/off/auto" switch:
 - 1. When the switch is in the hand position, the unit shall be enabled and the potentiometer shall control speed.
 - 2. When the switch is in "auto" position, the controller shall be started and stopped by a contract closure, and the speed shall be controlled by an input control signal.
 - 3. In the auto position, the speed of the unit shall be controlled by a SPDT Null controller. If the sensor indicates that the speed is below required speed (i.e., the pressure is too low) the controller shall increase in speed.

- 4. Conversely, when in the auto position, if the sensor indicates that the setpoint is being exceeded (i.e., the pressure is too high), the controller shall decrease in speed. If no signal is made, the controller shall remain at constant speed.
- 5. When the switch is in the "off" position, the motor shall be disconnected and shall not run.
- F. Acceleration/Deceleration: Acceleration time from 0 to full speed shall be adjustable from 30 to 300 seconds. Deceleration time shall be independently adjustable for the same range. A maximum frequency (speed) adjustment shall be available to allow less than 50 Hz output. A minimum frequency adjustment shall be available to set a minimum output frequency.

2.4 PROTECTION

- A. General: The VFD's shall be provided with means to protect itself and the motor from the following "faults":
 - 1. Overload
 - 2. Speed compensated overcurrent.
 - 3. In-rush current limit (adjustable 50 to 150%)
 - 4. Undervoltage and Overvoltage
 - 5. Overtemperature
 - 6. Short Circuit (3-phase and line-to-line)
 - 7. Ground fault
 - 8. Input and output phase loss
 - 9. Overfrequency
- B. Overload Protection: The VFD's shall be protected from momentary overload / overcurrent conditions as indicated below:
 - The VFD shall have a one (1) minute overload current rating of 110% for variable torque loads or motor supplied. Unit capacities shall match equipment as minimum, increased to allow normal equipment overloads in actual installation. The VFD and its associated equipment shall be considered as an integral unit for performance as required by this Project.
 - 2. A current limiter shall be provided. The current limiter shall be designed to function automatically to prevent over current trip due to momentary overload conditions, allowing the inverter to continue operation, and achieve full design capacity of the motor and connected load.
- C. Overcurrent Protection: The line side of the VFD's shall be equipped with a current limiting reactor to reduce the amount of fault current to the VFD's, which is coordinated with available AIC at service.
- D. Overcurrent Trip: The instantaneous overcurrent trip shall safely limit the output current in proper microseconds interval due to phase short circuit or severe overload conditions.
- E. Undervoltage/Overvoltage/Phase Loss: An undervoltage trip shall protect the inverter due to non-momentary power or phase loss. The undervoltage trip shall activate

automatically when the line voltage drops 15% below rated input voltage. The overvoltage trip shall protect the inverter due to voltage levels in excess of its rating.

- F. Temperature / Thermal Overload: An over temperature trip shall protect the inverter from elevated temperatures in excess of its rating.
 - 1. The over temperature light or indication on digital display shall indicate if the unit is tripped on over temperature.
 - 2. When the internal temperature is reduced to an acceptable level, the unit shall automatically start.
 - 3. The VFD panel shall provide visual indication when conditions are within 10 degrees F. of over-temperature shutdown, and upon shutdown.
 - 4. Motor Thermal Overload Protection shall be provided with door mounted reset button for the exact motor full load amps.
 - 5. Motor thermal overload relay shall be mounted inside the VFD cabinet.
- G. Short Circuit: In the event of a phase to phase short circuit, the control shall be designed to shut down safely without component failure.
- H. Ground Fault: Solid-state ground-fault protection and indication shall be provided with the VFD.
- I. Restart: The inverter logic shall allow that a trip condition resulting from over-current, under-voltage, or over-voltage shall automatically reset, and the inverter shall automatically restart upon correction of the trip condition. The number of restart attempts shall be limited to 5. If after 5 attempts the restart is not successful, the inverter shall shutdown safely and require manual restart.
- J. Loss of Power: In the event of a power loss, the control shall be designed to shutdown safely without component failure. Upon return of power, the system shall be designed to automatically return to normal operation (if the start is in the on condition) being able to restart into a rotating motor and regain positive speed control without shutdown or component failure.
- K. Switching: In the event that an input or output power contactor, disconnect switch, or circuit breaker is opened or closed while the control is activated, no damage to the unit shall result.

2.5 BYPASS MOTOR CONTROLLER

- A. Starter: VFD assembly shall contain a separate, across-the-line magnetic starter, sized to match motor and arranged for manually-activated emergency use in event of VFD system failure, controlled by same input data as VFD system.
- B. Bypass: The front door shall include the manual bypass switch. The bypass section door shall include a "VFD-Off-Bypass" selector switch, a "VFD Mode" indicator light and a "Bypass Mode" indicator light. Terminals shall be provided for remote indication of mode selection. In bypass mode the motor shall run at full speed directly from normal power. No electronic circuit shall be employed in the bypass mode. Motor protection thermal overload shall be provided in "bypass" and "normal" mode.
- C. Transfer: Manual bypass shall provide all the circuitry necessary to safely transfer the motor from the VFD to the power line, or from the line to the controller, while the motor is

at zero speed. The bypass shall not be located in the VFD section of the cabinet. The bypass section of the cabinet shall house all devices which must be energized at either line or control voltage while operating in the bypass mode.

- D. Contactors: Two motor contactors, electrically interlocked, shall be utilized. One contactor is to be between the VFD output and the motor, controlled by the VFD regulator; and the other one is to be between the bypass power line and the motor, providing across-the-line starting. The 115 VAC relay control logic, allowing common start-stop commands in the "controller" mode and the "bypass" mode shall also be included within the bypass enclosure.
- E. Interlock: The bypass option shall include a door interlocked, main power input disconnect, providing positive shutdown of all input power to both the bypass circuitry and the VFD.
- F. Factory Installed: Manual bypass with magnetic contactors shall be factory installed. Field modification of the VFD to provide manual bypass is not permitted.
- G. Optional Spare Drive: In lieu of bypass contactors, provide a minimum of two spare drives for each size VFD in the project. Submit a list of spare drives to be provided with the VFD submittal.

PART 3 - EXECUTION

3.1 GENERAL

- A. General: Provide Variable Frequency Drives for each motor identified as requiring a VFD or variable speed operation.
- B. Mounting: Floor mounted Variable Frequency Drives units shall be installed on housekeeping pads. Refer to paragraph entitled "HOUSEKEEPING PADS AND EQUIPMENT SUPPORTS" in Division 23050.
- C. Wiring Diagrams: The VFD shall be provided with all necessary wiring diagrams for installation and power wiring from the manufacturer.
- D. Coordination: Coordinate each VFD with the motor served and with the Controls System, paying specific attention to the signal input/output and the ground source.
- E. Startup: The VFD manufacturer shall provide, at no additional cost to the owner, a startup service package by a factory trained field service engineer for all VFDs provided. Service shall include inspection, final adjustments, operational checks, functional checks of spare parts (if provided) and a final report for record purpose. Start-up service shall be provided for each VFD. Start-up shall be performed with the cooperation of the controls sub-contractor and Commissioning Agent.
- F. Disconnect: Where a remote disconnect is provided for a motor controlled by a VFD, coordinate to ensure that a late make, early break auxiliary contact rated for ten (10) amps continuous duty is provided on the disconnect. This auxiliary contact must be wired into the VFD start circuit to ensure shut-down of the VFD in the event of the disconnect being opened.

G. Warranty: The service package shall include a comprehensive (replacement parts and labor) two-year warranty from date of Owner Acceptance or Substantial Completion (whichever is later) for all VFDs provided.

3.2 LOCATION OF VFD

- A. Location: The contractor shall coordinate the exact location of VFD with field conditions, keeping in mind that the locations shown on the construction drawings are diagrammatic.
- B. Distance from Motor: The maximum distance each VFD can be located from the motor it controls shall be as recommended by the manufacturer.
- C. Mounting: VFD may be mounted directly to masonry, CMU or concrete walls using appropriate fastening methods. When the wall is an exterior wall or any wall where condensation may occur, provide appropriate stand-off (i.e., insulation and/or unistrut mount). VFD may be mounted directly to equipment such as factory or field built AHU.
- D. Unistrut: When VFD is required to be located where suitable walls are not available, provide a Unistrut type frame securely mounted to the floor and adequately braced to form a rigid mounting surface.
- E. Floor Mounting: Provide 4" concrete housekeeping pad for all floor mounted units. Pad shall be 6" larger than VFD on all sides and shall have chamfered corners.
- F. Clearance: VFD shall be generally mounted with the center of the unit at a maximum of 60" above the finished floor. VFD's shall be accessible per the manufacturer's recommendations Service clearance shall be provided in accordance with NEC and under no circumstances less than the following:

Voltage to Ground	Min. Clearance Distance
0-120 V	3'-0"
121-277 V	4'-0"
greater than 277	V 5'-0"

3.3 AIR HANDLING UNIT SHUTDOWN

- A. Shutdown: When the VFD is used for control of an air handling unit or exhaust fan that is required to shut down upon activation of the fire alarm system, the VFD controller shall be connected to the fire alarm system and shall de-energize the VFD when the fire alarm system is in alarm. Coordinate with Division 26.
- B. H-O-A: The VFD shall be de-energized in "hand", "off", and "auto" modes. Switching between modes shall not reactivate motor until the fire alarm system is reset.
- C. Bypass: The VFD shall be de-energized in "VFD" and "Bypass" modes. Switching between modes shall not reactivate motor until the fire alarm system is reset.
- D. Restart: Upon reset of the fire alarm system and re-activation of the VFD, the motor shall "soft-start" and shall ramp up to its designated speed over a minimum of 30 seconds.

3.4 TRAINING

A. Training: Provide a minimum of 16 hours of training for all VFDs for the Owner and Owner's maintenance personnel.

END OF SECTION 23 0515

SECTION 23 0516 EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Slip-joint packed expansion joints.
 - 2. Expansion-compensator packless expansion joints.
 - 3. Flexible-hose packless expansion joints.
 - 4. Metal-bellows packless expansion joints.
 - 5. Rubber packless expansion joints.
 - 6. Pipe loops and swing connections.
 - 7. Alignment guides and anchors.

1.3 PERFORMANCE REQUIREMENTS

- A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.
- B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Delegated-Design Submittal: For each anchor and alignment guide indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
 - 2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
 - 3. Alignment Guide Details: Detail field assembly and attachment to building structure.
 - 4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.
- C. Welding certificates.
- D. Product Certificates: For each type of expansion joint, from manufacturer.

E. Maintenance Data: For expansion joints to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code Steel."
 - 2. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 PACKED EXPANSION JOINTS

- A. Slip-Joint Packed Expansion Joints:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Adsco Manufacturing LLC.
 - b. Advanced Thermal Systems, Inc.
 - c. Hyspan Precision Products, Inc.
 - d. Metraflex
 - 2. Standard: ASTM F 1007.
 - 3. Material: Carbon steel with asbestos-free PTFE packing.
 - 4. Design: With internal guide and injection device for repacking under pressure. Include drip connection if used for steam piping.
 - 5. Configuration: Single joint with base class(es) unless otherwise indicated.
 - 6. End Connections: Flanged or weld ends to match piping system.

2.2 PACKLESS EXPANSION JOINTS

- A. Metal, Expansion-Compensator Packless Expansion Joints:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Adsco Manufacturing LLC.
 - b. Flexicraft Industries.
 - c. Flex Pression Ltd.
 - d. Hyspan Precision Products, Inc.
 - e. Metraflex, Inc.
 - f. Unaflex.
 - 2. Minimum Pressure Rating: 175 psig unless otherwise indicated.
 - 3. Configuration for Copper Tubing: Two-ply, phosphor-bronze bellows with copper pipe ends.
 - a. End Connections for Copper Tubing NPS 2 and Smaller: Solder joint.

- b. End Connections for Copper Tubing NPS 2-1/2 to NPS 4: Threaded.
- 4. Configuration for Steel Piping: Two-ply, stainless-steel bellows; steel-pipe end connections; and carbon-steel shroud.
 - a. End Connections for Steel Pipe NPS 2 and Smaller: Threaded.
 - b. End Connections for Steel Pipe NPS 2-1/2 to NPS 4: Flanged.
- B. Flexible-Hose Packless Expansion Joints:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Flex-Hose Co., Inc.
 - b. Flexicraft Industries.
 - c. Flex Pression Ltd.
 - d. Metraflex, Inc.
 - e. Unisource Manufacturing, Inc.
 - 2. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.
 - 3. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.
 - 4. Expansion Joints for Copper Tubing NPS 2 and Smaller: Copper-alloy fittings with solder-joint end connections.
 - a. Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F and 340 psig at 450 deg F ratings.
 - b. Bronze hoses and double-braid bronze sheaths with 700 psig at 70 deg F and 500 psig at 450 deg F ratings.
 - 5. Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4: Copper-alloy fittings with threaded end connections.
 - a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 300 psig at 70 deg F and 225 psig at 450 deg F ratings.
 - b. Stainless-steel hoses and double-braid, stainless-steel sheaths with 420 psig at 70 deg F and 315 psig at 450 deg F ratings.
 - 6. Expansion Joints for Steel Piping NPS 2 and Smaller: Carbon-steel fittings with threaded end connections.
 - a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 450 psig at 70 deg F and 325 psig at 600 deg F ratings.
 - b. Stainless-steel hoses and double-braid, stainless-steel sheaths with 700 psig at 70 deg F and 515 psig at 600 deg F ratings.
 - 7. Expansion Joints for Steel Piping NPS 2-1/2 to NPS 6: Carbon-steel fittings with weld end connections.

- a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 200 psig at 70 deg F and 145 psig at 600 deg F ratings.
- b. Stainless-steel hoses and double-braid, stainless-steel sheaths with 275 psig at 70 deg F and 200 psig at 600 deg F ratings.
- 8. Expansion Joints for Steel Piping NPS 8 to NPS 12: Carbon-steel fittings with weld end connections.
 - a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 125 psig at 70 deg F and 90 psig at 600 deg F ratings.
 - b. Stainless-steel hoses and double-braid, stainless-steel sheaths with 165 psig at 70 deg F and 120 psig at 600 deg F ratings.
- 9. Expansion Joints for Steel Piping NPS 14 and Larger: Carbon-steel fittings with weld end connections.
 - a. Stainless-steel hoses and double-braid, stainless-steel sheaths with 165 psig at 70 deg F and 120 psig at 600 deg F ratings.
- C. Metal-Bellows Packless Expansion Joints:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Adsco Manufacturing LLC.
 - b. Flexicraft Industries.
 - c. Flex-Weld, Inc.
 - d. Hyspan Precision Products, Inc.
 - e. Metraflex, Inc.
 - 2. Standards: ASTM F 1120 and EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
 - 3. Type: Circular, corrugated bellows with external tie rods.
 - 4. Minimum Pressure Rating: 175 psig unless otherwise indicated.
 - 5. Configuration: Double joint with base class(es) unless otherwise indicated.
 - 6. Expansion Joints for Copper Tubing: Single- or multi-ply phosphor-bronze bellows, copper pipe ends, and brass shrouds.
 - a. End Connections for Copper Tubing NPS 2 and Smaller: Threaded.
 - b. End Connections for Copper Tubing NPS 2-1/2 to NPS 4: Threaded.
 - c. End Connections for Copper Tubing NPS 5 and Larger: Flanged.
 - 7. Expansion Joints for Steel Piping: Single- or multi-ply stainless-steel bellows, steel pipe ends, and carbon-steel shroud.
 - a. End Connections for Steel Pipe NPS 2 and Smaller: Threaded.
 - b. End Connections for Steel Pipe NPS 2-1/2 and Larger: Weld.

2.3 ALIGNMENT GUIDES AND ANCHORS

- A. Alignment Guides:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Adsco Manufacturing LLC.
 - b. Advanced Thermal Systems, Inc.
 - c. Flex-Hose Co., Inc.
 - d. Flexicraft Industries.
 - e. Flex-Weld, Inc.
 - f. Hyspan Precision Products, Inc.
 - g. Metraflex, Inc.
 - 2. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding spider for bolting to pipe.
- B. Anchor Materials:
 - 1. Steel Shapes and Plates: ASTM A 36/A 36M.
 - 2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
 - 3. Washers: ASTM F 844, steel, plain, flat washers.
 - 4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.
 - a. Stud: Threaded, zinc-coated carbon steel.
 - b. Expansion Plug: Zinc-coated steel.
 - c. Washer and Nut: Zinc-coated steel.
 - 5. Chemical Fasteners: Insert-type-stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.
 - a. Bonding Material: ASTM C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
 - b. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud unless otherwise indicated.
 - c. Washer and Nut: Zinc-coated steel.

PART 3 - EXECUTION

3.1 EXPANSION-JOINT INSTALLATION

A. Provision for Expansion: Piping shall be installed with provisions for expansion both horizontally and vertically in all long runs including runouts from risers. Expansion loops and/or expansion elbows shall be provided for expansion and contraction where required and where shown on the drawings.

- B. Cold Springing of Pipe: Cold spring hot piping systems to reduce the amount of thermal expansion of the piping.
- C. Pipe Anchors: Provide pipe anchors as indicated or as required to eliminate excessive piping movement in thermal and pressure piping systems.
- D. Install expansion components where required and as noted.
- E. Install packed-type expansion joints with packing suitable for fluid service.
- F. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."

3.2 PIPE LOOP AND SWING CONNECTION INSTALLATION

- A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.
- B. Connect risers and branch connections to mains with at least five pipe fittings including tee in main.
- C. Connect risers and branch connections to terminal units with at least four pipe fittings including tee in riser.
- D. Connect mains and branch connections to terminal units with at least four pipe fittings including tee in main.

3.3 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

- A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.
- B. Install two guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.
- C. Attach guides to pipe and secure guides to building structure.
- D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- E. Anchor Attachments:
 - 1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24, U-bolts bolted to anchor.
- F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
 - 1. Anchor Attachment to Steel Structural Members: Attach by welding.
 - 2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.

G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF DOCUMENT 23 0516

SECTION 23 0519 METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Bimetallic-actuated thermometers.
 - 2. Filled-system thermometers.
 - 3. Liquid-in-glass thermometers.
 - 4. Thermowells.
 - 5. Dial-type pressure gages.
 - 6. Gage attachments.
 - 7. Test plugs.
 - 8. Test-plug kits.
 - 9. Sight flow indicators.
 - 10. Pitot-tube flowmeters.
 - 11. Turbine flowmeters.
 - 12. Venturi flowmeters.
 - 13. Ultrasonic, thermal-energy meters.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Wiring Diagrams: For power, signal, and control wiring.
- C. Product Certificates: For each type of meter and gage, from manufacturer.
- D. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 BIMETALLIC-ACTUATED THERMOMETERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ashcroft Inc.
 - 2. Ernst Flow Industries.
 - 3. Marsh Bellofram.
 - 4. Trerice, H. O. Co.
 - 5. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
 - 6. Weiss Instruments, Inc.
- B. Standard: ASME B40.200.

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

- C. Case: Liquid-filled and sealed type(s); stainless steel with 5-inch nominal diameter.
- D. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F.
- E. Connector Type(s): Union joint, adjustable angle with unified-inch screw threads.
- F. Connector Size: 1/2 inch, with ASME B1.1 screw threads.
- G. Stem: 0.25 or 0.375 inch in diameter; stainless steel.
- H. Window: Plastic.
- I. Ring: Stainless steel.
- J. Element: Bimetal coil.
- K. Pointer: Dark-colored metal.
- L. Accuracy: Plus or minus 1 percent of scale range.

2.2 FILLED-SYSTEM THERMOMETERS

- A. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ashcroft Inc.
 - b. Marsh Bellofram.
 - c. Trerice, H. O. Co.
 - d. Weiss Instruments, Inc.
 - 2. Standard: ASME B40.200.
 - 3. Case: Sealed type, cast aluminum or drawn steel; 5-inch nominal diameter.
 - 4. Element: Bourdon tube or other type of pressure element.
 - 5. Movement: Mechanical, dampening type, with link to pressure element and connection to pointer.
 - 6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
 - 7. Pointer: Dark-colored metal.
 - 8. Window: Plastic.
 - 9. Ring: Stainless steel.
 - 10. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device; with ASME B1.1 screw threads.
 - 11. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
 - a. Design for Air-Duct Installation: With ventilated shroud.
 - b. Design for Thermowell Installation: Bare stem.

- 12. Accuracy: Plus or minus 1 percent of scale range.
- B. Direct-Mounted, Plastic-Case, Vapor-Actuated Thermometers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ashcroft Inc.
 - b. Miljoco Corporation.
 - c. REOTEMP Instrument Corporation.
 - 2. Standard: ASME B40.200.
 - 3. Case: Sealed type, plastic; 5-inch nominal diameter.
 - 4. Element: Bourdon tube or other type of pressure element.
 - 5. Movement: Mechanical, with link to pressure element and connection to pointer.
 - 6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
 - 7. Pointer: Dark-colored metal.
 - 8. Window: Plastic.
 - 9. Ring: Metal.
 - 10. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device; with ASME B1.1 screw threads.
 - 11. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
 - a. Design for Air-Duct Installation: With ventilated shroud.
 - b. Design for Thermowell Installation: Bare stem.
 - 12. Accuracy: Plus or minus 1 percent of scale range.

2.3 LIQUID-IN-GLASS THERMOMETERS

- A. Metal-Case, Compact-Style, Liquid-in-Glass Thermometers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Trerice, H. O. Co.
 - 2. Standard: ASME B40.200.
 - 3. Case: Cast aluminum; 6-inch nominal size.
 - 4. Case Form: Back angle unless otherwise indicated.
 - 5. Tube: Glass with magnifying lens and blue or red organic liquid.
 - 6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
 - 7. Window: Glass or plastic.
 - 8. Stem: Aluminum or brass and of length to suit installation.
 - a. Design for Air-Duct Installation: With ventilated shroud.
 - b. Design for Thermowell Installation: Bare stem.

- 9. Connector: 3/4 inch, with ASME B1.1 screw threads.
- 10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.
- B. Plastic-Case, Compact-Style, Liquid-in-Glass Thermometers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Flo Fab Inc.
 - b. Miljoco Corporation.
 - c. Tel-Tru Manufacturing Company.
 - d. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
 - e. Weiss Instruments, Inc.
 - f. WIKA Instrument Corporation USA.
 - 2. Standard: ASME B40.200.
 - 3. Case: Plastic; 6-inch nominal size.
 - 4. Case Form: Back angle unless otherwise indicated.
 - 5. Tube: Glass with magnifying lens and blue or red organic liquid.
 - 6. Tube Background: Nonreflective with permanently etched scale markings graduated in deg F.
 - 7. Window: Glass or plastic.
 - 8. Stem: Aluminum or brass and of length to suit installation.
 - a. Design for Air-Duct Installation: With ventilated shroud.
 - b. Design for Thermowell Installation: Bare stem.
 - 9. Connector: 3/4 inch, with ASME B1.1 screw threads.
 - 10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.
- C. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Flo Fab Inc.
 - b. Tel-Tru Manufacturing Company.
 - c. Trerice, H. O. Co.
 - d. Weiss Instruments, Inc.
 - e. Winters Instruments U.S.
 - 2. Standard: ASME B40.200.
 - 3. Case: Cast aluminum; 7-inch nominal size unless otherwise indicated.
 - 4. Case Form: Adjustable angle unless otherwise indicated.
 - 5. Tube: Glass with magnifying lens and blue or red organic liquid.
 - 6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
 - 7. Window: Plastic.

- 8. Stem: Aluminum and of length to suit installation.
 - a. Design for Air-Duct Installation: With ventilated shroud.
 - b. Design for Thermowell Installation: Bare stem.
- 9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
- 10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.4 DUCT-THERMOMETER MOUNTING BRACKETS

A. Description: Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.

2.5 THERMOWELLS

- A. Thermowells:
 - 1. Standard: ASME B40.200.
 - 2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
 - 3. Material for Use with Copper Tubing: CNR or CUNI.
 - 4. Material for Use with Steel Piping: CRES.
 - 5. Type: Stepped shank unless straight or tapered shank is indicated.
 - 6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
 - 7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
 - 8. Bore: Diameter required to match thermometer bulb or stem.
 - 9. Insertion Length: Length required to match thermometer bulb or stem.
 - 10. Lagging Extension: Include on thermowells for insulated piping and tubing.
 - 11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
- B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.6 PRESSURE GAGES

- A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AMETEK, Inc.; U.S. Gauge.
 - b. Ashcroft Inc.
 - c. Ernst Flow Industries.
 - d. Marsh Bellofram.
 - e. Trerice, H. O. Co.
 - f. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
 - g. Weiss Instruments, Inc.
 - h. WIKA Instrument Corporation USA.
 - i. Winters Instruments U.S.
 - 2. Standard: ASME B40.100.

- 3. Case: Liquid-filled type(s); cast aluminum or drawn steel 4-1/2-inch nominal diameter.
- 4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
- 5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
- 6. Movement: Mechanical, with link to pressure element and connection to pointer.
- 7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
- 8. Pointer: Dark-colored metal.
- 9. Window: Plastic.
- 10. Ring: Stainless steel.
- 11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.
- B. Direct-Mounted, Plastic-Case, Dial-Type Pressure Gages:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AMETEK, Inc.; U.S. Gauge.
 - b. Ashcroft Inc.
 - c. Marsh Bellofram.
 - d. Trerice, H. O. Co.
 - e. Weiss Instruments, Inc.
 - f. Winters Instruments U.S.
 - 2. Standard: ASME B40.100.
 - 3. Case: Sealed type; plastic; 4-1/2-inch nominal diameter.
 - 4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
 - 5. Match pressure connection size in first subparagraph below with gage attachment size.
 - 6. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2 ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
 - 7. Movement: Mechanical, with link to pressure element and connection to pointer.
 - 8. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
 - 9. Pointer: Dark-colored metal.
 - 10. Window: Plastic.
 - 11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.7 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston type surge-dampening device. Include extension for use on insulated piping.
- B. Siphons: Loop-shaped section of brass pipe with NPS 1/4 or NPS 1/2 pipe threads.
- C. Valves: Brass ball, brass or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

2.8 TEST PLUGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Flow Design, Inc.

- 2. Miljoco Corporation.
- 3. National Meter, Inc.
- 4. Peterson Equipment Co., Inc.
- 5. Sisco Manufacturing Company, Inc.
- 6. Trerice, H. O. Co.
- 7. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
- 8. Weiss Instruments, Inc.
- B. Description: Test-station fitting made for insertion into piping tee fitting.
- C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
- D. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.
- E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
- F. Core Inserts: EPDM self-sealing rubber.

2.9 TEST-PLUG KITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Flow Design, Inc.
 - 2. Peterson Equipment Co., Inc.
 - 3. Sisco Manufacturing Company, Inc.
 - 4. Trerice, H. O. Co.
 - 5. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
 - 6. Weiss Instruments, Inc.
- B. Furnish one test-plug kit(s) containing two thermometer(s), one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.
- C. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F.
- D. High-Range Thermometer: Small, bimetallic insertion type with 1 to 2 inch diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F.
- E. Pressure Gage: Small, Bourdon-tube insertion type with 2 to 3 inch diameter dial and probe. Dial range shall be at least 0 to 200 psig.
- F. Carrying Case: Metal or plastic, with formed instrument padding.

2.10 SIGHT FLOW INDICATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Archon Industries, Inc.
 - 2. Dwyer Instruments, Inc.
 - 3. Emerson Process Management; Brooks Instrument.

- 4. Ernst Co., John C., Inc.
- 5. Ernst Flow Industries.
- 6. KOBOLD Instruments, Inc. USA; KOBOLD Messring GmbH.
- 7. OPW Engineered Systems; a Dover company.
- 8. Penberthy; A Brand of Tyco Valves & Controls Prophetstown.
- B. Description: Piping inline-installation device for visual verification of flow.
- C. Construction: Bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.
- D. Minimum Pressure Rating: 150 psig.
- E. Minimum Temperature Rating: 200 deg F.
- F. End Connections for NPS 2 and Smaller: Threaded.
- G. End Connections for NPS 2-1/2 and Larger: Flanged.

2.11 WATER FLOW METERS

- A. Electromagnetic Meters:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Onicon; Incorporated.
 - 2. Description: Bi directional insertion flowmeter with sensor and indicator.
 - 3. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
 - 4. Sensor: Insertion type; for inserting probe into piping and measuring flow directly in gallons per minute.
 - a. Design: Differential-pressure-type measurement for water.
 - b. Construction: Stainless-steel probe of length to span inside of pipe, with integral transmitter and direct-reading scale.
 - c. Minimum Pressure Rating: 150 psig.
 - d. Minimum Temperature Rating: 250 deg F.
 - 5. Indicator: Hand-held meter; either an integral part of sensor or a separate meter.
 - 6. Integral Transformer: For low-voltage power connection.
 - 7. Accuracy: Plus or minus 1 percent.
 - 8. Display: Shows rate of flow, with register to indicate total volume in gallons.
 - 9. Operating Instructions: Include complete instructions with each flowmeter.
- B. Pitot-Tube Flow Meters:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABB; Instrumentation and Analytical.
 - b. Emerson Process Management; Rosemount.
 - c. Meriam Process Technologies.

- d. Preso Meters; a division of Racine Federated Inc.
- e. TACO Incorporated.
- f. Veris Industries, Inc.
- 2. Description: Flowmeter with sensor and indicator.
- 3. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
- 4. Sensor: Insertion type; for inserting probe into piping and measuring flow directly in gallons per minute.
 - a. Design: Differential-pressure-type measurement for water.
 - b. Construction: Stainless-steel probe of length to span inside of pipe, with integral transmitter and direct-reading scale.
 - c. Minimum Pressure Rating: 150 psig.
 - d. Minimum Temperature Rating: 250 deg F.
- 5. Indicator: Hand-held meter; either an integral part of sensor or a separate meter.
- 6. Integral Transformer: For low-voltage power connection.
- 7. Accuracy: Plus or minus 3 percent.
- 8. Display: Shows rate of flow, with register to indicate total volume in gallons.
- 9. Operating Instructions: Include complete instructions with each flowmeter.
- C. Turbine Flowmeters:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABB; Instrumentation and Analytical.
 - b. Data Industrial Corp.
 - c. EMCO Flow Systems; a division of Spirax Sarco, Inc.
 - d. ERDCO Engineering Corp.
 - e. Hoffer Flow Controls, Inc.
 - f. Liquid Controls; a unit of IDEX Corporation.
 - g. McCrometer, Inc.
 - h. Midwest Instruments & Controls Corp.
 - i. ONICON Incorporated.
 - j. SeaMetrics, Inc.
 - k. Sponsler, Inc.; a unit of IDEX Corporation.
 - 2. Description: Flowmeter with sensor and indicator.
 - 3. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
 - 4. Sensor: Impeller turbine; for inserting into pipe fitting or for installing in piping and measuring flow directly in gallons per minute.
 - a. Design: Device or pipe fitting with inline turbine and integral direct-reading scale for water.
 - b. Construction: Bronze or stainless-steel body, with plastic turbine or impeller.
 - c. Minimum Pressure Rating: 150 psig.
 - d. Minimum Temperature Rating: 180 deg F.

- 5. Indicator: Hand-held meter; either an integral part of sensor or a separate meter.
- 6. Accuracy: Plus or minus 1-1/2 percent.
- 7. Display: Shows rate of flow, with register to indicate total volume in gallons.
- 8. Operating Instructions: Include complete instructions with each flowmeter.
- D. Venturi Flowmeters:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABB; Instrumentation and Analytical.
 - b. Gerand Engineering Co.
 - c. Hyspan Precision Products, Inc.
 - d. Preso Meters; a division of Racine Federated Inc.
 - e. S. A. Armstrong Limited; Armstrong Pumps Inc.
 - f. Victaulic Company.
 - 2. Description: Flowmeter with calibrated flow-measuring element, hoses or tubing, fittings, valves, indicator, and conversion chart.
 - 3. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
 - 4. Sensor: Venturi-type, calibrated, flow-measuring element; for installation in piping.
 - a. Design: Differential-pressure-type measurement for water.
 - b. Construction: Bronze, brass, or factory-primed steel, with brass fittings and attached tag with flow conversion data.
 - c. Minimum Pressure Rating: 250 psig.
 - d. Minimum Temperature Rating: 250 deg F.
 - e. End Connections for NPS 2 and Smaller: Threaded.
 - f. End Connections for NPS 2-1/2 and Larger: Flanged or welded.
 - g. Flow Range: Flow-measuring element and flowmeter shall cover operating range of equipment or system served.
 - 5. Permanent Indicators: Meter suitable for wall or bracket mounting, calibrated for connected flowmeter element, and having 6-inch- diameter, or equivalent, dial with fittings and copper tubing for connecting to flowmeter element.
 - a. Scale: Gallons per minute.
 - b. Accuracy: Plus or minus 1 percent between 20 and 80 percent of scale range.
 - 6. Portable Indicators: Hand-held, differential-pressure type, calibrated for connected flowmeter element and having two 12-foot hoses, with carrying case.
 - a. Scale: Gallons per minute.
 - b. Accuracy: Plus or minus 2 percent between 20 and 80 percent of scale range.
 - 7. Display: Shows rate of flow, with register to indicate total volume in gallons.
 - 8. Conversion Chart: Flow rate data compatible with sensor.
 - 9. Operating Instructions: Include complete instructions with each flowmeter.

2.12 ULTRASONIC FLOW METER

- A. Ultrasonic Transit Time Flowmeter:
 - 1. The flowmeter must be a clamp on design precluding the requirement of penetrating into the pipe. The flowmeter shall be completely microprocessor based utilizing the transit time flow measurement technique. The flowmeter shall employ the phase detection multiple pulse transmit principal in conjunction with multiple frequency axial beam transducer technology to insure operation on liquids with solids and bubbles. In addition, the flowmeter shall incorporate an alternate Doppler method measurement mode for highly aerated or heavy solid bearing liquids. The furnished flowmeter shall be of a dual channel/path design. The dual channel operating mode shall be capable of acting as two independent meters with the ability to perform math functions between the two channels (add or subtract). The dual path operating mode will eliminate the effects of flow profile distortion, cross flow or swirl errors caused by upstream interference or pumping irregularities.
 - 2. The flowmeter shall provide automatic transducer spacing for clamp-on transducers utilizing a Universal Mounting Frame or mounting track (ruler scales shall not be acceptable), the meter shall also support in-line transducers. The meter shall also provide automatic Reynolds Number and liquid sonic velocity variation compensation and live zero flow measurement. The flowmeter shall have the ability to indicate flow rate, flow velocity, total flow, signal strength, liquid sonic velocity, Reynolds Number and liquid aeration level. The flowmeter shall be equipped with an integral front panel keypad and multifunction LCD display. In addition, the flowmeter shall provide self and application diagnostics to isolate any fault conditions to either equipment failure or abnormal process conditions. The flowmeter shall have HELP menu routines corresponding to all levels of programming and operation.
 - 3. The flowmeter electronics shall be housed in a NEMA 4X enclosure and powered by 120 VAC, 60Hz. Two isolated 4 to 20 maDC and two 0 to 5000 Hz pulse outputs proportional to flow shall be provided. The current outputs must be capable of driving a 1000 ohm resistive load. In addition, the unit shall provide two 0 to 10 volt outputs and four SPDT alarm relays assignable to flow velocity, liquid sonic velocity, signal strength or liquid aeration. An internal 250 KB (1 MB optional) datalogger shall be provided to allow storage of all measured and calculated variables and alarms.
 - 4. A bi-directional RS-232 connection shall be provided to allow remote programming and interrogation.
 - 5. The flowmeter shall have an accuracy of +/-1% of flow over a +/.20 fps flow range. Repeatability shall be +/- 0.25% of flow with a flow sensitivity of 0.001 fps at any flow rate including no flow conditions.
 - 6. Flowmeters that employ amplitude detection/correlation routines or use a single frequency transducer design will not be acceptable. Shear mode flowmeters or meters utilizing wetted transducers or electrodes, or flow measuring techniques other than previously described will not be accepted.
 - 7. Manufacturers:
 - a. Siemens Model FUS 1010 or FUE 1010.

- b. Flo-Corp Ultra Flo FCX
- c. Dynasonics TXFD

2.13 THERMAL-ENERGY METERS

- A. Ultrasonic, Thermal-Energy Meters:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. EMCO Flow Systems; a division of Spirax Sarco, Inc.
 - b. Siemens Energy & Automation, Inc.
 - c. Dynasonics
 - 2. Description: Meter with flow sensor, temperature sensors, transmitter, indicator, and connecting wiring.
 - 3. Flow Sensor: Transit-time ultrasonic type with transmitter.
 - 4. Temperature Sensors: Insertion-type or strap-on transducer.
 - 5. Indicator: Solid-state, integrating-type meter with integral battery pack.
 - a. Data Output: Six-digit electromechanical counter with readout in kilowatts per hour or British thermal units.
 - b. Battery Pack: Five-year lithium battery.
 - 6. Accuracy: Plus or minus 1 percent.
 - 7. Display: Visually indicates total fluid volume in gallons and thermal-energy flow in kilowatts per hour or British thermal units.
 - 8. Operating Instructions: Include complete instructions with each thermal-energy meter system.
 - 9. Building Control system interface: Provide communications network interface compatible with the Building Control System in Section 23 0900 using BACNet MS/TP or TCP/IP communications standard.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.

- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.
- G. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.
- H. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- I. Install valve and snubber in piping for each pressure gage for fluids (except steam).
- J. Install valve and syphon fitting in piping for each pressure gage for steam.
- K. Install test plugs in piping tees.
- L. Install flow indicators in piping systems in accessible positions for easy viewing.
- M. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.
- N. Install flowmeter elements in accessible positions in piping systems.
- O. Install differential-pressure-type flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.
- P. Install permanent indicators on walls or brackets in accessible and readable positions.
- Q. Install connection fittings in accessible locations for attachment to portable indicators.
- R. Mount thermal-energy meters on wall if accessible; if not, provide brackets to support meters.
- S. Install thermometers in the following locations:
 - 1. Inlet and outlet of each hydronic boiler.
 - 2. Two inlets and two outlets of each chiller.
 - 3. Inlet and outlet of each hydronic coil in air-handling units.
 - 4. Two inlets and two outlets of each hydronic heat exchanger.
- T. Install pressure gages in the following locations:
 - 1. Discharge of each pressure-reducing valve.
 - 2. Inlet and outlet of each chiller chilled-water and condenser-water connection.
 - 3. Suction and discharge of each pump.
 - 4. Inlet and Outlet of each hydronic coil in air handling units.

3.2 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

- B. Connect flowmeter-system elements to meters.
- C. Connect flowmeter transmitters to meters.
- D. Connect thermal-energy meter transmitters to meters.

3.3 ADJUSTING

- A. After installation, calibrate meters according to manufacturer's written instructions.
- B. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

- A. Thermometers at inlet and outlet of each hydronic boiler shall be one of the following:
 - 1. Liquid-filled, bimetallic-actuated type.
- B. Thermometers at inlets and outlets of each chiller shall be one of the following:
 - 1. Industrial style, liquid-in-glass type.
- C. Thermometers at inlet and outlet of each hydronic coil in air-handling units and built-up central systems shall be one of the following:
 - 1. Compact style, liquid-in-glass type.
- D. Thermometers at inlets and outlets of each hydronic heat exchanger shall be one of the following:
 - 1. Liquid-filled, bimetallic-actuated type.
- E. Thermometers at inlet and outlet of each hydronic heat-recovery unit shall be one of the following:
 - 1. Liquid-filled, bimetallic-actuated type.
- F. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

- A. Scale Range for Chilled-Water Piping: 0 to 100 deg F.
- B. Scale Range for Condenser Water Piping: 20 to 120 deg F.
- C. Scale Range for Heating, Hot-Water Piping: 30 to 240 deg F.

3.6 PRESSURE-GAGE SCHEDULE

- A. Pressure gages at discharge of each pressure-reducing valve shall be one of the following:
 - 1. Liquid-filled, direct mounted, metal case.

- B. Pressure gages at inlet and outlet of each chiller chilled-water and condenser-water connection shall be one of the following:
 - 1. Liquid-filled, direct mounted, metal case.
- C. Pressure gages at suction and discharge of each pump shall be the following:
 - 1. Liquid-filled, direct mounted, metal case.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

- A. Scale Range for Chilled-Water Piping: 0 to 100 psi.
- B. Scale Range for Condenser-Water Piping: 0 to 100 psi.
- C. Scale Range for Heating, Hot-Water Piping: 0 to 100 psi.
- D. Scale Range for Steam Piping: 0 to 200 psi.

3.8 FLOWMETER SCHEDULE

- A. Flowmeters for Chilled-Water Piping: Ultrasonic type.
- B. Flowmeters for Condenser-Water Piping: Turbine type.
- C. Flowmeters for Heating, Hot-Water Piping: Ultrasonic type.
- D. Flowmeters for Steam and Steam-Condensate Piping: Venturi type.

3.9 THERMAL-ENERGY METER SCHEDULE

- A. Thermal-Energy Meters for Chilled-Water Piping: Ultrasonic type.
- B. Thermal-Energy Meters for Condenser-Water Piping: Ultrasonic type.
- C. Thermal-Energy Meters for Heating, Hot-Water Piping: Ultrasonic type.
- D. Thermal-Energy Meters for Steam and Steam-Condensate Piping: Ultrasonic type.

END OF SECTION 23 0519

SECTION 23 0523 GENERAL DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Bronze angle valves.
 - 2. Brass ball valves.
 - 3. Bronze ball valves.
 - 4. Iron ball valves.
 - 5. Iron, single-flange butterfly valves.
 - 6. Iron, grooved-end butterfly valves.
 - 7. High-performance butterfly valves.
 - 8. Bronze lift check valves.
 - 9. Bronze swing check valves.
 - 10. Iron swing check valves.
 - 11. Iron swing check valves with closure control.
 - 12. Iron, grooved-end swing-check valves.
 - 13. Iron, center-guided check valves.
 - 14. Iron, plate-type check valves.
 - 15. Bronze gate valves.
 - 16. Iron gate valves.
 - 17. Bronze globe valves.
 - 18. Iron globe valves.
 - 19. Lubricated plug valves.
 - 20. Eccentric plug valves.
 - 21. Chainwheels.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Nonrising stem.
- E. OS&Y: Outside screw and yoke.
- F. RS: Rising stem.
- G. SWP: Steam working pressure.

1.4 SUBMITTALS

A. Product Data: For each type of valve indicated.

1.5 QUALITY ASSURANCE

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 - 1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 2. ASME B31.1 for power piping valves.
 - 3. ASME B31.9 for building services piping valves.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set angle, gate, and globe valves closed to prevent rattling.
 - 4. Set ball and plug valves open to minimize exposure of functional surfaces.
 - 5. Set butterfly valves closed or slightly open.
 - 6. Block check valves in either closed or open position.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Refer to HVAC valve schedule articles for applications of valves.
- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- C. Valve Sizes: Same as upstream piping unless otherwise indicated.
- D. Valve Actuator Types:
 - 1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
 - 2. Handwheel: For valves other than quarter-turn types.
 - 3. Handlever: For quarter-turn valves NPS 6 and smaller.
 - 4. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug-valve head.

- 5. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.
- E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
 - 1. Gate Valves: With rising stem.
 - 2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
 - 3. Butterfly Valves: With extended neck.
- F. Valve-End Connections:
 - 1. Flanged: With flanges according to ASME B16.1 for iron valves.
 - 2. Grooved: With grooves according to AWWA C606.
 - 3. Solder Joint: With sockets according to ASME B16.18.
 - 4. Threaded: With threads according to ASME B1.20.1.
- G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE ANGLE VALVES

- A. Class 125, Bronze Angle Valves with Bronze Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hammond Valve.
 - b. Milwaukee Valve Company.
 - c. Nibco Inc.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded.
 - e. Stem and Disc: Bronze.
 - f. Packing: Asbestos free.
 - g. Handwheel: Malleable iron.
- B. Class 150, Bronze Angle Valves with Bronze Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Stockham Division.
 - b. Kitz Corporation.
 - c. Milwaukee Valve Company
 - d. Nibco, Inc.
 - 2. Description:
- a. Standard: MSS SP-80, Type 1.
- b. CWP Rating: 300 psig.
- c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
- d. Ends: Threaded.
- e. Stem and Disc: Bronze.
- f. Packing: Asbestos free.
- g. Handwheel: Malleable iron.

2.3 BRONZE BALL VALVES

- A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Conbraco Industries, Inc.; Apollo Valves.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Hammond Valve.
 - d. Milwaukee Valve Company.
 - e. NIBCO INC.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Two piece.
 - e. Body Material: Bronze.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Bronze.
 - i. Ball: Chrome-plated brass.
 - j. Port: Full.
- B. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Conbraco Industries, Inc.; Apollo Valves.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Two piece.
 - e. Body Material: Bronze.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Stainless steel.
 - i. Ball: Stainless steel, vented.

j. Port: Full.

2.4 IRON, SINGLE-FLANGE BUTTERFLY VALVES

- A. 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Conbraco Industries, Inc.; Apollo Valves.
 - b. Crane Co.; Crane Valve Group; Stockham Division.
 - c. Hammond Valve.
 - d. Milwaukee Valve Company.
 - e. NIBCO INC.
 - f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 150 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
 - e. Seat: EPDM.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Aluminum bronze.
- B. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Conbraco Industries, Inc.; Apollo Valves.
 - b. Crane Co.; Crane Valve Group; Stockham Division.
 - c. Hammond Valve.
 - d. Milwaukee Valve Company.
 - e. NIBCO INC.
 - f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
 - e. Seat: EPDM.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Aluminum bronze.

2.5 IRON, GROOVED-END BUTTERFLY VALVES

- A. 175 CWP, Iron, Grooved-End Butterfly Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Kennedy Valve; a division of McWane, Inc.
 - b. Shurjoint Piping Products.
 - c. Tyco Fire Products LP; Grinnell Mechanical Products.
 - d. Victaulic Company.
 - e. Milwaukee Valve Company.
 - f. Nibco, Inc.
 - 2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 175 psig.
 - c. Body Material: Coated, ductile iron.
 - d. Stem: Two-piece stainless steel.
 - e. Disc: Coated, ductile iron.
 - f. Seal: EPDM.
- B. 300 CWP, Iron, Grooved-End Butterfly Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International, Inc.
 - b. Kennedy Valve; a division of McWane, Inc.
 - c. Mueller Steam Specialty; a division of SPX Corporation.
 - d. NIBCO INC.
 - e. Shurjoint Piping Products.
 - f. Tyco Fire Products LP; Grinnell Mechanical Products.
 - g. Victaulic Company.
 - h. Milwaukee Valve Company.
 - 2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. NPS 8 and Smaller CWP Rating: 300 psig.
 - c. NPS 10 and Larger CWP Rating: 200 psig.
 - d. Body Material: Coated, ductile iron.
 - e. Stem: Two-piece stainless steel.
 - f. Disc: Coated, ductile iron.
 - g. Seal: EPDM.

2.6 BRONZE LIFT CHECK VALVES

- A. Class 125, Lift Check Valves with Bronze Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Milwaukee Valve Company
 - c. Nibco, Inc.

- 2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Vertical flow.
 - d. Body Material: ASTM B 61 or ASTM B 62, bronze.
 - e. Ends: Threaded.
 - f. Disc: Bronze.

2.7 BRONZE SWING CHECK VALVES

- A. Class 125, Bronze Swing Check Valves with Bronze Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Stockham Division.
 - b. Hammond Valve.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
 - e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 3.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B 62, bronze.
 - e. Ends: Threaded.
 - f. Disc: Bronze.
- B. Class 150, Bronze Swing Check Valves with Bronze Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Valve, Inc.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Kitz Corporation.
 - d. Milwaukee Valve Company.
 - e. NIBCO INC.
 - f. Red-White Valve Corporation.
 - g. Zy-Tech Global Industries, Inc.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 3.
 - b. CWP Rating: 300 psig.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B 62, bronze.
 - e. Ends: Threaded.
 - f. Disc: Bronze.

2.8 IRON SWING CHECK VALVES

- A. Class 125, Iron Swing Check Valves with Metal Seats:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Hammond Valve.
 - c. Kitz Corporation.
 - d. Legend Valve.
 - e. Milwaukee Valve Company.
 - f. NIBCO INC.
 - g. Powell Valves.
 - h. Red-White Valve Corporation.
 - i. Sure Flow Equipment Inc.
 - j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - k. Zy-Tech Global Industries, Inc.
 - 2. Description:
 - a. Standard: MSS SP-71, Type I.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
 - d. Body Design: Clear or full waterway.
 - e. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - f. Ends: Flanged.
 - g. Trim: Bronze.
 - h. Gasket: Asbestos free.
- B. Class 250, Iron Swing Check Valves with Metal Seats:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Hammond Valve.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
 - e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-71, Type I.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 300 psig.
 - d. Body Design: Clear or full waterway.
 - e. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - f. Ends: Flanged.
 - g. Trim: Bronze.
 - h. Gasket: Asbestos free.

2.9 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

A. Class 125, Iron Swing Check Valves with Lever- and Spring-Closure Control:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. NIBCO INC.
 - b. Milwaukee Valve Company
- 2. Description:
 - a. Standard: MSS SP-71, Type I.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
 - d. Body Design: Clear or full waterway.
 - e. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - f. Ends: Flanged.
 - g. Trim: Bronze.
 - h. Gasket: Asbestos free.
 - i. Closure Control: Factory-installed, exterior lever and spring.

2.10 IRON, GROOVED-END SWING CHECK VALVES

- A. 300 CWP, Iron, Grooved-End Swing Check Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International, Inc.
 - b. Shurjoint Piping Products.
 - c. Tyco Fire Products LP; Grinnell Mechanical Products.
 - d. Victaulic Company.
 - e. Milwaukee Valve Company
 - f. Nibco, Inc.
 - 2. Description:
 - a. CWP Rating: 300 psig.
 - b. Body Material: ASTM A 536, ductile iron.
 - c. Seal: EPDM.
 - d. Disc: Spring operated, ductile iron or stainless steel.

2.11 IRON, CENTER-GUIDED CHECK VALVES

- A. Class 125, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Hammond Valve.
 - b. Metraflex, Inc.
 - c. Milwaukee Valve Company.
 - d. Mueller Steam Specialty; a division of SPX Corporation.
 - e. NIBCO INC.
 - f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

- 2. Description:
 - a. Standard: MSS SP-125.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
 - d. Body Material: ASTM A 126, gray iron.
 - e. Style: Compact wafer.
 - f. Seat: Bronze.
- B. Class 125, Iron, Globe, Center-Guided Check Valves with Metal Seat:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Hammond Valve.
 - b. Metraflex, Inc.
 - c. Milwaukee Valve Company.
 - d. Mueller Steam Specialty; a division of SPX Corporation.
 - e. NIBCO INC.
 - f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-125.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
 - d. Body Material: ASTM A 126, gray iron.
 - e. Style: Globe, spring loaded.
 - f. Ends: Flanged.
 - g. Seat: Bronze.
- C. Class 150, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. APCO Willamette Valve and Primer Corporation.
 - b. Crispin Valve.
 - c. Val-Matic Valve & Manufacturing Corp.
 - d. Milwaukee Valve Company.
 - e. Nibco, Inc.
 - 2. Description:
 - a. Standard: MSS SP-125.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 300 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 250 psig.
 - d. Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
 - e. Style: Compact wafer.
 - f. Seat: Bronze.
- D. Class 150, Iron, Globe, Center-Guided Check Valves with Metal Seat:

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. APCO Willamette Valve and Primer Corporation.
 - b. Crispin Valve.
 - c. Val-Matic Valve & Manufacturing Corp.
 - d. Milwaukee Valve Company
 - e. Nibco, Inc.
- 2. Description:
 - a. Standard: MSS SP-125.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 300 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 250 psig.
 - d. Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
 - e. Style: Globe, spring loaded.
 - f. Ends: Flanged.
 - g. Seat: Bronze.
- E. Class 250, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Hammond Valve.
 - b. Metraflex, Inc.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
 - e. Sure Flow Equipment Inc.
 - f. Val-Matic Valve & Manufacturing Corp.
 - 2. Description:
 - a. Standard: MSS SP-125.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 300 psig.
 - d. Body Material: ASTM A 126, gray iron.
 - e. Style: Compact wafer, spring loaded.
 - f. Seat: Bronze.
- F. Class 250, Iron, Globe, Center-Guided Check Valves with Metal Seat:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Hammond Valve.
 - b. Metraflex, Inc.
 - c. Milwaukee Valve Company.
 - d. Mueller Steam Specialty; a division of SPX Corporation.
 - e. NIBCO INC.
 - 2. Description:

- a. Standard: MSS SP-125.
- b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
- c. NPS 14 to NPS 24, CWP Rating: 300 psig.
- d. Body Material: ASTM A 126, gray iron.
- e. Style: Globe, spring loaded.
- f. Ends: Flanged.
- g. Seat: Bronze.
- G. Class 300, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Milwaukee Valve Company
 - b. Nibco, Inc.
 - 2. Description:
 - a. Standard: MSS SP-125.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 400 psig.
 - d. Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
 - e. Style: Compact wafer, spring loaded.
 - f. Seat: Bronze.
- H. Class 300, Iron, Globe, Center-Guided Check Valves with Metal Seat:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Milwaukee Valve Company.
 - b. Nibco, Inc.
 - 2. Description:
 - a. Standard: MSS SP-125.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 400 psig.
 - d. Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
 - e. Style: Globe, spring loaded.
 - f. Ends: Flanged.
 - g. Seat: Bronze.

2.12 IRON, PLATE-TYPE CHECK VALVES

A. Class 125, Iron, Dual-Plate Check Valves with Metal Seat:

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Mueller Steam Specialty; a division of SPX Corporation.
 - b. Milwaukee Valve Company.
 - c. Nibco, Inc.
- 2. Description:
 - a. Standard: API 594.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
 - d. Body Design: Wafer, spring-loaded plates.
 - e. Body Material: ASTM A 126, gray iron.
 - f. Seat: Bronze.
- B. Class 150, Iron, Dual-Plate Check Valves with Metal Seat:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Mueller Steam Specialty; a division of SPX Corporation.
 - c. Milwaukee Valve Company.
 - d. Nibco, Inc.
 - 2. Description:
 - a. Standard: API 594.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 300 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 250 psig.
 - d. Body Design: Wafer, spring-loaded plates.
 - e. Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
 - f. Seat: Bronze.
- C. Class 250, Iron, Dual-Plate Check Valves with Metal Seat:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. APCO Willamette Valve and Primer Corporation.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Milwaukee Valve Company.
 - d. Nibco, Inc.
 - 2. Description:
 - a. Standard: API 594.

- b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
- c. NPS 14 to NPS 24, CWP Rating: 300 psig.
- d. Body Design: Wafer, spring-loaded plates.
- e. Body Material: ASTM A 126, gray iron.
- f. Seat: Bronze.
- D. Class 300, Iron, Dual-Plate Check Valves with Metal Seat:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Mueller Steam Specialty; a division of SPX Corporation.
 - c. Milwaukee Valve Company.
 - d. Nibco, Inc.
 - 2. Description:
 - a. Standard: API 594.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 400 psig.
 - d. Body Design: Wafer, spring-loaded plates.
 - e. Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
 - f. Seat: Bronze.

2.13 BRONZE GATE VALVES

- A. Class 125, NRS Bronze Gate Valves:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Hammond Valve.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
 - e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded.
 - e. Stem: Bronze.
 - f. Disc: Solid wedge; bronze.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron, bronze or aluminum.
- B. Class 125, RS Bronze Gate Valves:

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Hammond Valve.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
 - e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- 2. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded.
 - e. Stem: Bronze.
 - f. Disc: Solid wedge; bronze.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron, bronze or aluminum.
- C. Class 150, NRS Bronze Gate Valves:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Hammond Valve.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 300 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
 - d. Ends: Threaded.
 - e. Stem: Bronze.
 - f. Disc: Solid wedge; bronze.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron, bronze or aluminum.
- D. Class 150, RS Bronze Gate Valves:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Hammond Valve.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
 - e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

- 2. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 300 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
 - d. Ends: Threaded.
 - e. Stem: Bronze.
 - f. Disc: Solid wedge; bronze.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron, bronze or aluminum.

2.14 IRON GATE VALVES

- A. Class 125, NRS, Iron Gate Valves:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Hammond Valve.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
 - e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-70, Type I.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
 - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - e. Ends: Flanged.
 - f. Trim: Bronze.
 - g. Disc: Solid wedge.
 - h. Packing and Gasket: Asbestos free.
- B. Class 125, OS&Y, Iron Gate Valves:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Hammond Valve.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
 - e. Powell Valves.
 - f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-70, Type I.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
 - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - e. Ends: Flanged.

- f. Trim: Bronze.
- g. Disc: Solid wedge.
- h. Packing and Gasket: Asbestos free.
- C. Class 250, NRS, Iron Gate Valves:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. NIBCO Inc.
 - c. Milwaukee Valve Company
 - 2. Description:
 - a. Standard: MSS SP-70, Type I.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 300 psig.
 - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - e. Ends: Flanged.
 - f. Trim: Bronze.
 - g. Disc: Solid wedge.
 - h. Packing and Gasket: Asbestos free.
- D. Class 250, OS&Y, Iron Gate Valves:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Hammond Valve.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
 - e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-70, Type I.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 300 psig.
 - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - e. Ends: Flanged.
 - f. Trim: Bronze.
 - g. Disc: Solid wedge.
 - h. Packing and Gasket: Asbestos free.

2.15 BRONZE GLOBE VALVES

- A. Class 125, Bronze Globe Valves with Bronze Disc:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:

- a. Crane Co.; Crane Valve Group; Crane Valves.
- b. Hammond Valve.
- c. Milwaukee Valve Company.
- d. NIBCO INC.
- e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- 2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded.
 - e. Stem and Disc: Bronze.
 - f. Packing: Asbestos free.
 - g. Handwheel: Malleable iron, bronze or aluminum.

2.16 IRON GLOBE VALVES

- A. Class 125, Iron Globe Valves:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Hammond Valve.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
 - e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-85, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - d. Ends: Flanged.
 - e. Trim: Bronze.
 - f. Packing and Gasket: Asbestos free.

2.17 LUBRICATED PLUG VALVES

- A. Class 125, Regular-Gland, Lubricated Plug Valves with Threaded Ends:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Nordstrom Valves, Inc.
 - b. Milwaukee Valve Company
 - c. Nibco, Inc.
 - 2. Description:
 - a. Standard: MSS SP-78, Type II.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.

- d. Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
- e. Pattern: Regular or short.
- f. Plug: Cast iron or bronze with sealant groove.
- B. Class 125, Regular-Gland, Lubricated Plug Valves with Flanged Ends:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Nordstrom Valves, Inc.
 - b. Milwaukee Valve Company
 - c. Nibco, Inc.
 - 2. Description:
 - a. Standard: MSS SP-78, Type II.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
 - d. Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
 - e. Pattern: Regular or short.
 - f. Plug: Cast iron or bronze with sealant groove.
- C. Class 125, Cylindrical, Lubricated Plug Valves with Threaded Ends:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Homestead Valve; a division of Olson Technologies, Inc.
 - b. Milliken Valve Company.
 - c. R & M Energy Systems; a unit of Robbins & Myers, Inc.
 - d. Milwaukee Valve Company
 - e. Nibco, Inc.
 - 2. Description:
 - a. Standard: MSS SP-78, Type IV.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
 - d. Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
 - e. Pattern: Regular or short.
 - f. Plug: Cast iron or bronze with sealant groove.
- D. Class 125, Cylindrical, Lubricated Plug Valves with Flanged Ends:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Homestead Valve; a division of Olson Technologies, Inc.
 - b. Milliken Valve Company.
 - c. R & M Energy Systems; a unit of Robbins & Myers, Inc.
 - d. Milwaukee Valve Company

- e. Nibco, Inc.
- 2. Description:
 - a. Standard: MSS SP-78, Type IV.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
 - d. Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
 - e. Pattern: Regular or short.
 - f. Plug: Cast iron or bronze with sealant groove.
- E. Class 250, Regular-Gland, Lubricated Plug Valves with Threaded Ends:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Nordstrom Valves, Inc.
 - b. Milwaukee Valve Company
 - c. Nibco, Inc.
 - 2. Description:
 - a. Standard: MSS SP-78, Type II.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 300 psig.
 - d. Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
 - e. Pattern: Regular or short.
 - f. Plug: Cast iron or bronze with sealant groove.
- F. Class 250, Regular-Gland, Lubricated Plug Valves with Flanged Ends:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 - a. Nordstrom Valves, Inc.
 - b. Milwaukee Valve Company
 - c. Nibco, Inc.
 - 2. Description:
 - a. Standard: MSS SP-78, Type II.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 300 psig.
 - d. Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
 - e. Pattern: Regular or short.
 - f. Plug: Cast iron or bronze with sealant groove.
- G. Class 250, Cylindrical, Lubricated Plug Valves with Threaded Ends:

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Homestead Valve; a division of Olson Technologies, Inc.
 - b. Milliken Valve Company.
 - c. R & M Energy Systems; a unit of Robbins & Myers, Inc.
 - d. Milwaukee Valve Company
 - e. Nibco, Inc.
- 2. Description:
 - a. Standard: MSS SP-78, Type IV.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 300 psig.
 - d. Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
 - e. Pattern: Regular or short.
 - f. Plug: Cast iron or bronze with sealant groove.
- H. Class 250, Cylindrical, Lubricated Plug Valves with Flanged Ends:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Homestead Valve; a division of Olson Technologies, Inc.
 - b. Milliken Valve Company.
 - c. R & M Energy Systems, a unit of Robbins & Myers, Inc.
 - d. Milwaukee Valve Company
 - e. Nibco, Inc.
 - 2. Description:
 - a. Standard: MSS SP-78, Type IV.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 300 psig.
 - d. Body Material: ASTM A 48/A 48M or ASTM A 126, Grade 40 cast iron with lubrication-sealing system.
 - e. Pattern: Regular or short.
 - f. Plug: Cast iron or bronze with sealant groove.

2.18 CHAINWHEELS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. Babbitt Steam Specialty Co.
 - 2. Roto Hammer Industries.
 - 3. Trumbull Industries.
- B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
 - 1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
 - 2. Retain first subparagraph below for ball, butterfly, and plug valves.
 - 3. Attachment: For connection to ball butterfly and plug valve stems.

- 4. Retain only ductile iron in first subparagraph below unless another material is required.
- 5. Sprocket Rim with Chain Guides: Ductile or cast iron of type and size required for valve. Include zinc coating.
- 6. Retain only first option in subparagraph below unless another material is required.
- 7. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install chain wheels on operators for ball, butterfly, gate, globe and plug valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.
- F. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
 - 2. Center-Guided and Plate-Type Check Valves: In horizontal or vertical position, between flanges.
 - 3. Lift Check Valves: With stem upright and plumb.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Ball, butterfly, or gate valves.
 - 2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
 - 3. Throttling Service except Steam: Globe or angle valves.
 - 4. Throttling Service, Steam: Globe or angle valves.
 - 5. Pump-Discharge Check Valves:
 - a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
 - b. NPS 2-1/2 and Larger: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal seat check valves.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
 - 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
 - 3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
 - 4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
 - 5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valveend option is indicated in valve schedules below.
 - 6. For Steel Piping, NPS 5 and Larger: Flanged ends.
 - 7. For Grooved-End Copper Tubing and Steel Piping except Steam, Steam Condensate and Chilled Water Piping: Valve ends may be grooved.

3.5 CHILLED-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller:
 - 1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
 - 2. Retain only valve types, in five subparagraphs below, required for Project.
 - 3. Bronze Angle Valves: Class 150, bronze disc.
 - 4. Caution: No one-piece, reduced-port, brass ball valves with stainless-steel trim; three-piece, regular-port, brass ball valves with brass trim; or bronze ball valves with bronze trim are included in the Section Text. Retain brass or stainless-steel trim with brass ball valves, or bronze or stainless-steel trim with bronze ball valves.
 - 5. Ball Valves: Two piece, full port, bronze with brass trim.
 - 6. Bronze Swing Check Valves: Class 150, bronze disc.
 - 7. Bronze Gate Valves: Class 150, RS, bronze.
- B. Pipe NPS 2-1/2 and Larger:

- 1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
- 2. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: 200 CWP, EPDM seat, aluminum-bronze disc.
- 3. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24: 150 CWP, EPDM seat, aluminum-bronze disc.
- 4. Iron, Grooved-End Butterfly Valves, NPS 2-1/2 to NPS 12: 300 CWP.
- 5. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12: Class 125, lever and spring.
- 6. Iron, Grooved-End Check Valves, NPS 3 to NPS 12: 300 CWP.
- 7. Iron Gate Valves: Class 250, OS&Y.
- 8. Lubricated Plug Valves: Class 250, cylindrical, threaded.

3.6 CONDENSER-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller:
 - 1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
 - 2. Bronze Angle Valves: Class 150, bronze disc.
 - 3. Ball Valves: Two piece, full port, bronze with brass trim.
 - 4. Bronze Swing Check Valves: Class 150, bronze disc.
 - 5. Bronze Gate Valves: Class 150, RS.
- B. Pipe NPS 2-1/2 and Larger:
 - 1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
 - 2. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: 200 CWP, EPDM seat, aluminum-bronze disc.
 - 3. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24: 150 CWP, EPDM seat, aluminum-bronze disc.
 - 4. Iron, Grooved-End Butterfly Valves, NPS 2-1/2 to NPS 12: [175] [300] CWP.
 - 5. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12: Class 125, lever and spring.
 - 6. Iron Gate Valves: Class 250, OS&Y.
 - 7. Lubricated Plug Valves: Class 250, cylindrical.

3.7 HEATING-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller:
 - 1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
 - 2. Bronze Angle Valves: Class 150, bronze disc.
 - 3. Ball Valves: Two piece, full port, bronze with brass trim.
 - 4. Bronze Swing Check Valves: Class 150, bronze disc.
 - 5. Bronze Gate Valves: Class 150 RS.
- B. Pipe NPS 2-1/2 and Larger:
 - 1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.

- 2. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: 200 CWP, EPDM seat, aluminum-bronze disc.
- 3. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24: 150 CWP, EPDM seat, aluminum-bronze disc.
- 4. Iron, Grooved-End Butterfly Valves, NPS 2-1/2 to NPS 12: 300 CWP.
- 5. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12: Class 125, lever and spring.
- 6. Iron, Grooved-End Check Valves, NPS 3 to NPS 12: 300 CWP.
- 7. Iron, Center-Guided Check Valves: Class 150, compact-wafer, metal seat.
- 8. Iron Gate Valves: Class 250, OS&Y.

END OF SECTION 23 0523

SECTION 23 0529 HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 **RELATED DOCUMENTS**

Α. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- Α. This Section includes the following hangers and supports for HVAC system piping and equipment:
 - Steel pipe hangers and supports. 1.
 - Trapeze pipe hangers. 2.
 - 3. Metal framing systems.
 - Thermal-hanger shield inserts. 4.
 - Fastener systems. 5.
 - 6. Pipe stands.
 - 7. Equipment supports.

DEFINITIONS 1.3

- Α. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.
- Β. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

- Α. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
- Β. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 SUBMITTALS

- Α. Product Data: For the following:
 - 1. Steel pipe hangers and supports.
 - 2. Thermal-hanger shield inserts.

1.6 QUALITY ASSURANCE

- Welding: Qualify procedures and personnel according to the following: Α.

 - AWS D1.1, "Structural Welding Code--Steel."
 AWS D1.2, "Structural Welding Code--Aluminum."
 - 3. AWS D1.3, "Structural Welding Code--Sheet Steel."
 - 4. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
 - 5. ASME Boiler and Pressure Vessel Code: Section IX.

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- B. Manufacturers:
 - 1. B-Line Systems, Inc.; a division of Cooper Industries.
 - 2. Grinnell Corp.
 - 3. National Pipe Hanger Corporation.
 - 4. Tolco Inc.
- C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.
- D. Nonmetallic Coatings: PVC for use on copper piping.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

- A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
- B. Manufacturers:
 - 1. B-Line Systems, Inc.; a division of Cooper Industries.
 - 2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
 - 3. GS Metals Corp.
 - 4. Power-Strut Div.; Tyco International, Ltd.
 - 5. Thomas & Betts Corporation.
 - 6. Tolco Inc.
 - 7. Unistrut Corp.; Tyco International, Ltd.
- C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.

2.5 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.

- B. Manufacturers:
 - 1. Carpenter & Paterson, Inc.
 - 2. ERICO/Michigan Hanger Co.
 - 3. PHS Industries, Inc.
 - 4. Pipe Shields, Inc.
 - 5. Rilco Manufacturing Company, Inc.
- C. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with vapor barrier.
- D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate.
- E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

- A. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 1. Manufacturers:
 - a. B-Line Systems, Inc.; a division of Cooper Industries.
 - b. Empire Industries, Inc.
 - c. Hilti, Inc.
 - d. ITW Ramset/Red Head.
 - e. MKT Fastening, LLC.

f. Powers Fasteners.

2.7 PIPE STAND FABRICATION

- A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand: One-piece plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
 - 1. Manufacturers:
 - a. ERICO/Michigan Hanger Co.
 - b. MIRO Industries.
- C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.
 - 1. Manufacturers:
 - a. MIRO Industries.

- D. High-Type, Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
 - 1. Manufacturers:
 - a. ERICO/Michigan Hanger Co.
 - b. MIRO Industries.
 - c. Portable Pipe Hangers.
 - 2. Base: Stainless steel.
 - 3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
 - 4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.
- E. High-Type, Multiple-Pipe Stand: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
 - 1. Manufacturers:
 - a. Portable Pipe Hangers.
 - 2. Bases: One or more plastic.
 - 3. Vertical Members: Two or more protective-coated-steel channels.
 - 4. Horizontal Member: Protective-coated-steel channel.
 - 5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.
- F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

2.8 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structuralsteel shapes.

2.9 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use padded hangers for piping that is subject to scratching.
- F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
 - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
 - 5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 - 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.
 - 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
 - 8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
 - 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.
 - 10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.
 - 11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3.

- 12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
- 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
- 14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
- 15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
- 16. Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
- 17. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
- Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
- 19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
- 20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
- 21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
 - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
- H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 - 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 - 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 - 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 - 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

- I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 - 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
 - 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 - 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 - 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 - 6. C-Clamps (MSS Type 23): For structural shapes.
 - 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 - 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 - 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 - 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 - 11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 - 12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 - 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 - 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 - 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.

- 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
- 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 - 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 - 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
 - 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 - 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
 - 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
 - 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
 - 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- N. Use mechanical-expansion anchors instead of building attachments where required in concrete construction. All mechanical expansion anchors shall be approved by the Structural Engineer prior to use.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
 - 1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Pipe Stand Installation:
 - 1. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 - 2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 07 Section "Roof Accessories" for curbs.
- G. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- I. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- J. Install lateral bracing with pipe hangers and supports to prevent swaying.
- K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- L. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

- M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.
- N. Insulated Piping: Comply with the following:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weightdistribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weightdistribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
 - 5. Pipes NPS 8 and Larger: Include wood inserts.
 - 6. Insert Material: Length at least as long as protective shield.
 - 7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

- A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 23 0529

SECTION 23 0548 VIBRATION CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Isolation pads.
 - 2. Isolation mounts.
 - 3. Restrained elastomeric isolation mounts.
 - 4. Restrained spring isolators.
 - 5. Housed spring mounts.
 - 6. Elastomeric hangers.
 - 7. Spring hangers.
 - 8. Spring hangers with vertical-limit stops.
 - 9. Pipe riser resilient supports.
 - 10. Resilient pipe guides.
 - 11. Restrained vibration isolation roof-curb rails.
 - 12. Steel and inertia, vibration isolation equipment bases.

1.3 DEFINITIONS

- A. IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.
- C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.4 PERFORMANCE REQUIREMENTS

- A. Wind-Restraint Loading:
 - 1. Basic Wind Speed: 150 mp.
 - 2. Building Classification Category: I.
 - 3. Minimum 10 lb/sq. ft. multiplied by the maximum area of the HVAC component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.

- B. Delegated-Design Submittal: For vibration isolation details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, wind forces required to select vibration isolators, wind restraints, and for designing vibration isolation bases.
 - a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Division 22 Sections for equipment mounted outdoors.
 - 2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure and spring deflection changes. Include certification that riser system has been examined for excessive stress and that none will exist.
 - 3. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.
 - 4. Wind Restraint Details:
 - a. Design Analysis: To support selection and arrangement of wind restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during wind load events. Indicate association with vibration isolation devices.
 - c. Coordinate vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Division 22 Sections for equipment mounted outdoors.
 - d. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).
- C. Coordination Drawings: Show coordination of bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports.
- D. Welding certificates.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Amber/Booth Company, Inc.
 - 2. Kinetics Noise Control.
 - 3. Mason Industries.
- B. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
 - 1. Resilient Material: Oil- and water-resistant neoprene.
- C. Mounts: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.
 - 1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
 - 2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.
- D. Restrained Mounts: All-directional mountings with seismic restraint.
 - 1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
 - 2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.
- E. Spring Isolators: Freestanding, laterally stable, open-spring isolators.
 - 1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
 - 6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
- F. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
 - 1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
 - 2. Restraint: Seismic or limit stop as required for equipment and authorities having jurisdiction.
 - 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- G. Housed Spring Mounts: Housed spring isolator with integral seismic snubbers.
 - 1. Housing: Ductile-iron or steel housing to provide all-directional seismic restraint.
 - 2. Base: Factory drilled for bolting to structure.
 - 3. Snubbers: Vertically adjustable to allow a maximum of 1/4-inch travel up or down before contacting a resilient collar.
- H. Elastomeric Hangers: Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.
- I. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
 - 1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 - 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washerreinforced cup to support spring and bushing projecting through bottom of frame.
 - 7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.
- J. Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.
 - 1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.

- 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
- 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
- 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
- 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
- 7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
- 8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.
- K. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch- thick neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig and for equal resistance in all directions.
- L. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch- thick neoprene. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction shall be fitted. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.2 RESTRAINED VIBRATION ISOLATION ROOF-CURB RAILS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Amber/Booth Company, Inc.
 - 2. Kinetics Noise Control.
 - 3. Mason Industries.
 - 4. Thybar Corporation.
- B. General Requirements for Restrained Vibration Isolation Roof-Curb Rails: Factoryassembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand seismic and wind forces.
- C. Lower Support Assembly: Formed sheet-metal section containing adjustable and removable steel springs that support upper frame. Upper frame shall provide continuous support for equipment and shall be captive to resiliently resist seismic and wind forces. Lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches of rigid, glass-fiber insulation on inside of assembly.
- D. Spring Isolators: Adjustable, restrained spring isolators shall be mounted on 1/4-inchthick, elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be

located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.

- 1. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with wind restraint.
 - a. Housing: Steel with resilient vertical-limit stops and adjustable equipment mounting and leveling bolt.
 - b. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - c. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - d. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- 2. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel base plates, and factory cut to sizes that match requirements of supported equipment.
 - a. Resilient Material: Oil- and water-resistant standard neoprene.
- E. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counter flashed over roof materials.

2.3 VIBRATION ISOLATION EQUIPMENT BASES

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Amber/Booth Company, Inc.
 - 2. Kinetics Noise Control.
 - 3. Mason Industries.
- B. Steel Base: Factory-fabricated, welded, structural-steel bases and rails.
 - 1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - a. Include supports for suction and discharge elbows for pumps.
 - 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
 - 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
- C. Inertia Base: Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.
 - 1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - a. Include supports for suction and discharge elbows for pumps.

- 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
- 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
- 4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.4 FACTORY FINISHES

- A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
 - 1. Powder coating on springs and housings.
 - 2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
 - 3. Baked enamel or powder coat for metal components on isolators for interior use.
 - 4. Color-code or otherwise mark vibration isolation and seismic and wind control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic and wind control devices for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION-CONTROL DEVICE INSTALLATION

A. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

- B. Piping Restraints:
 - 1. Comply with requirements in MSS SP-127.
 - 2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
 - 3. Brace a change of direction longer than 12 feet.
- C. Install cables so they do not bend across edges of adjacent equipment or building structure.
- D. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- E. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- F. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- G. Drilled-in Anchors:
 - Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavyduty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - 4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 - 5. Set anchors to manufacturer's recommended torque, using a torque wrench.
 - 6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
 - 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.

- 2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
- 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
- 4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
- 5. Test to 90 percent of rated proof load of device.
- 6. Measure isolator restraint clearance.
- 7. Measure isolator deflection.
- 8. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Prepare test and inspection reports.

3.5 ADJUSTING

- A. Adjust isolators after piping system is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Adjust active height of spring isolators.
- D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 23 0548

SECTION 23 0548.13 VIBRATION CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Elastomeric isolation pads.
 - 2. Elastomeric isolation mounts.
 - 3. Restrained elastomeric isolation mounts.
 - 4. Open-spring isolators.
 - 5. Housed-spring isolators.
 - 6. Restrained-spring isolators.
 - 7. Housed-restrained-spring isolators.
 - 8. Pipe-riser resilient supports.
 - 9. Resilient pipe guides.
 - 10. Air-spring isolators.
 - 11. Restrained-air-spring isolators.
 - 12. Elastomeric hangers.
 - 13. Spring hangers.
 - 14. Vibration isolation equipment bases.
 - 15. Restrained isolation roof-curb rails.
 - 16. Flexible Pipe Connectors And Guides
- B. Related Requirements:
 - 1. Section 21 0548.13 "Vibration Controls for Fire Suppression" for devices for firesuppression equipment and systems.
 - 2. Section 22 0548.13 "Vibration Controls for Plumbing" for devices for plumbing equipment and systems.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 - 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device type required.
- B. Shop Drawings:
 - 1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

- 2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
- C. Delegated-Design Submittal: For each vibration isolation device.
 - 1. Include design calculations for selecting vibration isolators and for designing vibration isolation bases.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of vibration isolation device installation for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.
- B. Qualification Data: For testing agency.
- C. Welding certificates.
- D. Air-Mounting System Performance Certification: Include natural frequency, load, and damping test data[**performed by an independent agency**].

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For [air-spring mounts] [and] [restrained-air-spring mounts] to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.7 APPROVED MANUFACTURERS

A. The vibration control equipment in this Section is based upon the products of Mason Industries, Inc., other acceptable manufacturers are as listed per product type.

PART 2 - PRODUCTS

2.1 ISOLATOR TYPE A (ELASTOMERIC ISOLATION PADS)

- A. Elastomeric Isolation Pads:
 - 1. Manufacturer: Subject to compliance with requirements, provide product by <u>Mason</u> <u>Industries, Inc. – Type NK</u> or comparable product by one of the following:
 - a. <u>Ace Mountings Co., Inc</u>.
 - b. <u>Kinetics Noise Control, Inc</u>.
 - c. <u>Vibration Isolation</u>.
 - 2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area. Sandwich cork with two layers of neoprene waffle.
 - 3. Size: Factory or field cut to match requirements of supported equipment.
 - 4. Pad Material: Oil and water resistant with elastomeric properties.

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 121505 Vibration Controls for HVAC Section 23 0548.13 - 2

- 5. Surface Pattern: Waffle pattern.
- 6. Minimum $\frac{1}{2}$ inch thickness.
- 7. Load-bearing metal plates adhered to pads.

2.2 ISOLATOR TYPE B (ELASTOMERIC ISOLATION MOUNTS)

- A. Double-Deflection, Elastomeric Isolation Mounts:
 - 1. Manufacturer: Subject to compliance with requirements, provide product by <u>Mason</u> <u>Industries, Inc. – Type ND</u> or comparable product by one of the following:
 - a. Amber-Booth
 - b. Kinetics Noise Control, Inc.
 - c. <u>Vibro-Acoustics</u>
 - 2. Mounting Plates:
 - a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
 - b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
 - 3. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.3 ISOLATOR TYPE C (RESTRAINED ELASTOMERIC ISOLATION MOUNTS)

- A. Restrained Elastomeric Isolation Mounts:
 - 1. Manufacturer: Subject to compliance with requirements, provide product by <u>Mason</u> <u>Industries, Inc.- Type BR</u> or comparable product by one of the following:
 - a. <u>Amber-Booth</u>
 - b. <u>Kinetics Noise Control, Inc</u>.
 - c. <u>Vibro-Acoustics</u>
 - 2. Description: All-directional isolator with restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
 - a. Housing: Cast-ductile iron or welded steel.
 - b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.4 ISOLATOR TYPE D (OPEN-SPRING ISOLATORS)

- A. Freestanding, Laterally Stable, Open-Spring Isolators:
 - 1. Manufacturer: Subject to compliance with requirements, provide product by <u>Mason</u> <u>Industries, Inc. – Type SLF</u> or comparable product by one of the following:
 - a. <u>Amber-Booth</u>
 - b. <u>Kinetics Noise Control, Inc</u>.
 - c. Vibro-Acoustics
 - 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

- 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- 6. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psig (3447 kPa).
- 7. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

2.5 ISOLATOR TYPE E (HOUSED-SPRING ISOLATORS)

- A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing:
 - 1. Manufacturer: Subject to compliance with requirements, provide product by <u>Mason</u> <u>Industries, Inc. – Type C</u> or comparable product by one of the following:
 - a. Amber-Booth
 - b. <u>Kinetics Noise Control, Inc.</u>
 - c. <u>Vibro-Acoustics</u>
 - 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - 6. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.
 - a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig (3447 kPa).
 - b. Top housing with attachment and leveling bolt.

2.6 ISOLATOR TYPE F (RESTRAINED-SPRING ISOLATORS)

- A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint:
 - 1. Manufacturer: Subject to compliance with requirements, provide product by <u>Mason</u> <u>Industries, Inc. – Type SLR</u> or comparable product by one of the following:
 - a. <u>Amber-Booth</u>
 - b. <u>Kinetics Noise Control, Inc</u>.
 - c. <u>Vibro-Acoustics</u>
 - 2. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
 - a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig (3447 kPa).
 - b. Top plate with threaded mounting holes.
 - c. Internal leveling bolt that acts as blocking during installation.
 - 3. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
 - 4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.7 TYPE [Insert Option Here] (HOUSED-RESTRAINED-SPRING ISOLATORS)

- A. Manufacturers: Subject to compliance with requirements, provide products by <u>Mason Industries</u>, <u>Inc. – Type</u> [Insert Option Here] or comparable product by one of the following:
 - 1. <u>Kinetics Noise Control</u>.
 - 2. Vibro-Acoustics
 - 3. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with [adjustable] [non-adjustable] snubbers to limit vertical movement.
 - a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig (3447 kPa).
 - b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.
 - 4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.8 TYPE [Insert Option Here] (AIR-SPRING ISOLATORS)

- A. Freestanding, Single or Multiple, Compressed-Air Bellows: < Insert drawing designation >.
 - 1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
 - <u>Basis-of-Design Product</u>: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
 - a. <u>Firestone Industrial Products Company</u>.
 - b. <u>Mason Industries, Inc</u>.
 - c. <Insert manufacturer's name>.
 - 3. Bellows Assembly: Upper and lower powder-coated steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows or similar elastomeric material.
 - 4. Maximum Natural Frequency: 3 Hz.
 - 5. Operating Pressure Range: 25 to 100 psig (172 to 690 kPa).
 - 6. Burst Pressure: At least three times manufacturer's published maximum operating pressure.
 - 7. Tank valves.

2.9 TYPE [Insert Option Here] (RESTRAINED-AIR-SPRING ISOLATORS)

- A. Freestanding, Single or Multiple, Compressed-Air Bellows with Vertical-Limit Stop Restraint: <**Insert drawing designation**>.
 - 1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers

offering products that may be incorporated into the Work include, but are not limited to, the following]: Basis-of-Design Product: Subject to compliance with requirements, provide [product

- Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
 - a. Firestone Industrial Products Company.
 - b. Mason Industries, Inc.
 - c. <Insert manufacturer's name>.
- 3. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
 - a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig (3447 kPa).
 - b. Top plate with [threaded mounting holes] [elastomeric pad].
 - c. Internal leveling bolt that acts as blocking during installation.
- 4. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
- 5. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
- 6. Minimum Additional Travel: 50 percent of the required deflection at rated load.
- 7. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
- 8. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- 9. Bellows Assembly: Upper and lower powder-coated steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows or similar elastomeric material.
- 10. Maximum Natural Frequency: 3 Hz.
- 11. Operating Pressure Range: 25 to 100 psig (172 to 690 kPa).
- 12. Burst Pressure: At least three times manufacturer's published maximum operating pressure.
- 13. Tank valves.

2.10 ISOLATOR TYPE G (ELASTOMERIC HANGERS)

- A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:
 - 1. Manufacturer: Subject to compliance with requirements, provide product by <u>Mason</u> <u>Industries, Inc. – Type HD</u> or comparable product by one of the following:
 - a. <u>Amber Booth</u>.
 - b. Kinetics Noise Control, Inc.
 - c. <u>Vibro-Acoustics</u>
 - 2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
 - 3. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.11 ISOLATOR TYPE H (SPRING HANGERS)

 A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:
1. Manufacturer: Subject to compliance with requirements, provide product by <u>Mason</u> <u>Industries, Inc. - Type DNHS</u> or comparable product by one of the following:

- a. <u>Amber Booth</u>.
- b. <u>Kinetics Noise Control, Inc</u>.
- c. Vibro-Acoustics
- 2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
- 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
- 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
- 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
- 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- 7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
- 8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
- 9. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

2.12 ISOLATOR TYPES I AND K (VIBRATION ISOLATION EQUIPMENT BASES)

- A. Manufacturers: Subject to compliance with requirements, provide products by <u>Mason Industries</u>, <u>Inc</u> or comparable product by one of the following:
 - 1. <u>Kinetics Noise Control</u>.
 - 2. <u>Vibro-Acoustics</u>
- B. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails. <u>Mason Industries, Inc.</u> <u>– Type WFSL</u> – (TYPE I)
 - Design Requirements: Lowest possible mounting height with not less than 1-inch (25mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - a. Include supports for suction and discharge elbows for pumps.
 - 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
 - 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
- C. Concrete Inertia Base: Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete. <u>Mason Industries, Inc. Type KSL</u> (TYPE K)
 - 1. Design Requirements: Lowest possible mounting height with not less than 1-inch (25mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - a. Include supports for suction and discharge elbows for pumps.
 - 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
 - 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.13 ISOLATOR TYPE L (RESTRAINED ISOLATION ROOF-CURB RAILS)

- A. Manufacturers: Subject to compliance with requirements, provide products by <u>Mason Industries</u>, <u>Inc – Type CMAB</u> or comparable product by one of the following:
 - 1. Kinetics Noise Control.
 - 2. Vibro-Acoustics
- B. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment.
- C. Upper Frame: Upper frame shall provide continuous and captive support for equipment.
- D. Lower Support Assembly: The lower support assembly shall be formed sheet metal section containing adjustable and removable steel springs that support upper frame. The lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials and shall be insulated with a minimum of 2 inches (50 mm) of rigid glass-fiber insulation on inside of assembly. Adjustable, restrained-spring isolators shall be mounted on elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.
- E. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch (6 mm) thick.
- F. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

2.14 ISOLATOR TYPE M (FLOATING FLOORS)

- A. Manufacturers: Subject to compliance with requirements, provide products by <u>Mason Industries</u>, <u>Inc</u> or comparable product by one of the following:
 - 1. <u>Kinetics Noise Control</u>.
 - 2. <u>Vibro-Acoustics</u>
- B. The floating floor system shall consist of 3000 PCF concrete "floating" slab of 6" minimum thickness, the isolation material and the supporting floor structure.
- C. Isolation System: Shall consist of 1/2 inch C grade, sheathing, EXP-1, fir, 4 ply. Plywood concrete pouring form supported by precompressed molded fiber glass noise and vibration isolation pads, individually coated with a flexible moisture- impervious membrane. Fiber glass pads shall have satisfactorily passed WMATA Section 3.49 dynamic test for isolator performance.
- D. Isolation Pads shall be cylindrical LDS mountings with a diameter no less than 0.9 of the 2"(50mm) height. Isolators are molded to AASHTO bridge bearing specification. Maximum durometer 60. Deflections shall not exceed 0.3"(7.5mm) nor the frequency 10Hz. Isolators shall be Mason Industries Type EAFM.

- E. Alternate Isolation Pads shall be 2 inches thick and shall be of flame-annealed glass fibers with nominal fiber diameters not to exceed 0.00027 inch, and shall have been stabilized by precompression. The isolation pads shall be spaced on 12 to 16 inch centers each way. Low density fiber glass noise absorption material 1.08 PCF, NRC .87, 1-1/2 inches thick, shall be bonded to the entire area between the isolation pads. Junction Plates: For maintaining planar alignment of isolation panels, plates shall be 4" x 4", 16 ga. galvanized steel attached at four (4) points using power-driven screws. Junction plates shall be as recommended by isolation manufacturer. Isolation material shall be Kinetics Noise Control, Inc., Type RIM
- F. Design: The bearing surface area of each pad shall be determined by the isolation manufacturer on the basis of final evaluation of concentrated and uniformly imposed loads, but in no case shall the uniform load range be less than 200 PSF to maintain an essentially constant natural frequency of 15 Hz or lower and uniform deflection of the floating floor. The floating floor system shall have a minimum rating of STC-79 and INR+17 as verified by an independent laboratory in prior tests.
- G. Perimeter Isolation Board: Minimum 3/4"(20mm) thick 10 Lb. per cubic foot(160 kg/m3) fiberglass isolation board. Isolation board shall Mason Industries AFG-10.
- H. Perimeter Caulking Compound: Non-hardening, drying or bleeding. Troweling or pouring grade. Caulking compound shall be Mason Industries Type CC-75.
- I. Plywood Covering Material: A. Provide one (1) layer of 6 mil (0.15mm) polyethylene sheeting.
- J. Permeter curb to be 6" thick, and 6" wide concrete constructed per 03 30 00 specifications.
- K. Equipment shall be mounted directly on the floating floor as shown on the drawings.
- L. In seismic zones double acting resilient cast in floating floor snubbers shall consist of a ductile iron housing locked into the floating floor to withstand the seismic forces with a maximum deflection of 0.2"(5mm). The housing shall have a removable cover plate to provide access to the adjustment of resilient stop clearances in both the up and down directions. Resilient stops shall be attached to a restraining bolt attached to the structural floor with an approved anchor. Double acting snubbers shall be Mason Industries Type SFFS.

2.15 FLEXIBLE PIPE CONNECTORS AND GUIDES

- A. Manufacturers: Subject to compliance with requirements, provide products by <u>Mason Industries</u>, <u>Inc</u> or comparable product by one of the following:
 - 1. <u>Amber Booth</u>
 - 2. Proco
 - 3. Victaulic.
- B. (TYPE N) Flexible Pipe Connector: Flexible stainless steel hose constructed of stainless steel braid and carbon steel fittings. Connections: Male threaded ends for piping 2-1/2 inches and smaller and flanged ends for piping 3 inches and larger. Lengths as recommended by manufacturer. Mason Industries, Inc. – Type FFLSS
- C. (TYPE O) Non-ferrous single arch expansion joint connector fabricated of multiple plies of nylon cord, fabric and neoprene; furnished with metallic flanges which are independent of the casing and retained by beaded ends which fit into machined grooves, forming a liquid tight seal without gasketing. Provide bolted stabilizing/control rods to maintain anchoring where required, due to size or operating pressure. Mason Industries, Inc. Type SFEJ

- D. (TYPE P) Non-ferrous twin arch expansion joint connector fabricated of multiple plies of nylon cord, fabric and neoprene; furnished with metallic flanges which are independent of the casing and retained by beaded ends which fit into machined grooves, forming a liquid tight seal without gasketing. Provide bolted stabilizing/control rods to maintain anchoring where required, due to size or operating pressure. Mason Industries, Inc. Type SFDEJ
- E. (TYPE Q) Pipe Guide: stainless steel wrapping the carbon steel foot where it passes through horizontal U guides similarly lined to prevent corrosion. The baseplate shall have multiple holes for bolting to beam flanges or flat surfaces. Bases may be welded in position in lieu of bolting. Height must be adjustable to accept different thicknesses of insulation. Guides shall be professionally load rated for bottom, overhead, side mounted or riser positioning to provide both load bearing and guiding capabilities. Mason Industries, Inc. – Type ASG
- F. (TYPE R) Pipe Guide: Spider type, using stainless steel ring and mounting plate, with a pipe ring and guide shield sized to accept the pipe insulation thickness. Mason Industries Type SPG
- G. (TYPE S) Pipe Anchor: All directional acoustical pipe anchor, consisting of a telescopic arrangement of two sizes of steel tubing separated by a minimum 1/2 inch thickness of heavy duty neoprene and duck or neoprene isolation material. Vertical restraints provided by similar material arranged to prevent vertical travel in either direction. Allowable loads on the isolator material not to exceed 500 PSI and the design balanced for equal resistance in any direction. Mason Industries Type ADA.
- H. On Victaulic installations, Styles 77, 177, or W77 flexible couplings may be used in lieu each flexible connector for vibration isolation and noise reduction at equipment connections. Three (3) couplings for each connector shall be placed in close proximity to the source of vibration in accordance with manufacturer's guidelines.
- I.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PIPING IN MECHANICAL EQUIPMENT AND AIR HANDLING UNIT ROOMS

- A. General:
 - 1. Isolators for equipment and piping are described elsewhere in this division. The vibration isolation manufacturer shall coordinate the selection of piping supports with equipment supports to provide a carefully engineered system designed to accommodate expansion and contraction without excessive stress or misalignment at equipment connections or in the piping.
 - 2. Temporary anchors, where required, shall be installed to permit pre-adjustment of springs in risers.

- 3. Permanent limit stops shall be installed to prevent excessive vertical motion of risers in the event water is drained from system. Locations and other details of these limit stops shall be submitted to the Architect for acceptance.
- 4. Piping connected to vibration isolated equipment shall not strain or force out of alignment the vibration isolators supporting the basic equipment, nor shall pipes restrict such equipment from "floating" freely on its respective vibration isolation system.
- 5. Piping connected to vibrating equipment shall not physically contact any building construction or non-isolated systems or components.
- 6. The weight of the pipe shall not be carried by walls through which the pipe passes.
- B. At Equipment Connections:
 - 1. At the pump outlet, provide isolator TYPE N.
 - 2. At the chilled and hot water supply and return connections to the air handler, provide isolator TYPE M.
 - 3. At locations shown on the drawings for pipe guides, provide guide TYPE P or Q, and anchors provide TYPE R.

3.3 VIBRATION CONTROL DEVICE INSTALLATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in [Section 03 3000 "Cast-in-Place Concrete."] [Section 03 3053 "Miscellaneous Cast-in-Place Concrete."]
- B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

3.4 AIR-SPRING ISOLATORS INSTALLATION

- A. Independent Isolator Installation:
 - 1. Install tank valve into each air isolator.
 - 2. Inflate each isolator to [height] [and] [pressure] specified on Drawings.
- B. Pressure-Regulated Isolator Installation:
 - 1. Coordinate the constant pressure-regulated air supply to air springs with the requirements for piping and connections specified in Section 22 1513 "General-Service Compressed-Air Piping."
 - 2. Connect all pressure regulators to a single dry, filtered [facility] [constant] air supply.
 - 3. Inflate isolators to [height] [and] [or] [pressure] specified on Drawings.

3.5 VIBRATION ISOLATION EQUIPMENT BASES INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in [Section 03 3000 "Cast-in-Place Concrete."] [Section 03 3053 "Miscellaneous Cast-in-Place Concrete."]

3.6 VIBRATION ISOLATION SCHEDULE

A. Provide mechanical equipment with vibration isolation according to the following schedule:

EQUIPMENT

ISOLATOR TYPE

Base mounted pumps Inline pumps Air handling units – floor mounted Air handling units – vertical - floor mounted Air handling units – suspended	D, [I] or [K], and [N] [O] [P] A [A] [D and K] [B] [C] [G] [H]
Air handling unit – custom	M
Condensing units	[B] [C] [D]
Fans - Suspended	[G] [H]
Fans - floor mounted	[B] [C] [D and L]
Fans – Roof mounted (utility type)	D
Centrifugal Chiller	[A] [F]
Cooling Tower	[F]
Rotary Chiller	[A] [F]
Boiler	[A]
Temperature Control Air Compressor	[D]
Packaged Rooftop Air Conditioning Units	[L]

B. Provide the following piping systems with vibration isolation according to PART 3 of this Section:

- 1. Chilled Water Piping
- 2. Hot Water Piping
- 3. Refrigerant Piping
- 4. Condenser Water Piping
- 5. Steam Supply and Steam Condensate Return Piping

END OF SECTION 23 0548.13

SECTION 23 0553 IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Duct labels.
 - 5. Stencils.
 - 6. Valve tags.
 - 7. Warning tags.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- C. Valve numbering scheme.
- D. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
 - 1. Material and Thickness: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

- 3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- 4. Fasteners: Stainless-steel rivets or self-tapping screws.
- 5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Plastic Labels for Equipment:
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
 - 2. Letter Color: White.
 - 3. Background Color: Blue.
 - 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
 - 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 - 6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - 7. Fasteners: Stainless-steel rivets or self-tapping screws.
 - 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
- D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: White.
- C. Background Color: Red.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches.

2.4 STENCILS

- A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches for ducts; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.
 - 1. Stencil Material: Fiberboard or metal.
 - 2. Stencil Paint: Exterior, gloss, acrylic enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
 - 3. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1 unless otherwise indicated.

2.5 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
 - 1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Fasteners: Brass wire-link or beaded chain; or S-hook.

- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - 1. Valve-tag schedule shall be included in operation and maintenance data.

2.6 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
 - 1. Size: Approximately 4 by 7 inches.
 - 2. Fasteners: Brass grommet and wire.
 - 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 - 4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

- A. General: Paint all exposed piping, insulation, equipment, structural bases, racks, in equipment rooms and on roof, furnished under Division 23 of these specifications. All exposed metal surfaces shall be given one prime coat and two finish coats. All insulated surfaces shall be given one coat of glue sizing (omit this step if factory applied finish is suitable to receive prime coat), one prime coat and one finish coat. Factory painted or finished items do not require field painting but shall require "touch-up" with matching paint or finish where scratched. Follow manufacturer's recommendations on ambient conditions for painting, coat thickness, and drying time between coats.
- B. Inaccessible Items: Equipment not completely accessible for painting when set in place shall be thoroughly cleaned and painted before installation and suitably protected.
- C. Concealed Items: Concealed piping need not be painted.
- D. Metal Surfaces: Use a scraper or wire brush to remove rust and roughen metal surfaces prior to painting. After wire brushing, wash surfaces to remove particulates, apply primer coat after surface is dry but not more than 48 hours after wire brushing.
- E. Colors: Colors for piping systems and equipment which are required to be painted shall be as indicated in the following table:

Class	Paint Color
F – Fire Protection Equipment	Red
D – Dangerous Material	Yellow (or Orange)
S – Safe Material	Green (or the achromatic colors White, Black, Gray or Aluminum)
P – Protective Material	Bright Blue
V – Valuable Material	Deep Purple

TABLE - PIPING PAINTING SCHEDULE

- F. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- G. Pipe Label Color Schedule:
 - 1. Chilled-Water Piping:
 - a. Background Color: Blue.
 - b. Letter Color: White.
 - 2. Condenser-Water Piping:
 - a. Background Color: Green.
 - b. Letter Color: White.
 - 3. Heating Water Piping:
 - a. Background Color: Yellow.
 - b. Letter Color: White.
 - 4. Refrigerant Piping:
 - a. Background Color: Black.
 - b. Letter Color: White.
 - 5. Low-Pressure Steam Piping:
 - a. Background Color: Yellow.
 - b. Letter Color: White.

- 6. High-Pressure Steam Piping:
 - a. Background Color: Yellow.
 - b. Letter Color: White.
- 7. Steam Condensate Piping:
 - a. Background Color: Yellow.
 - b. Letter Color: White.

3.4 DUCT LABEL INSTALLATION

- A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:
 - 1. Blue: For cold-air supply ducts.
 - 2. Yellow: For hot-air supply ducts.
 - 3. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
 - 4. ASME A13.1 Colors and Designs: For hazardous material exhaust.
- B. Stenciled Duct Label Option: Stenciled labels, showing service and flow direction, may be provided instead of plastic-laminated duct labels, at Installer's option, if lettering larger than 1 inch high is needed for proper identification because of distance from normal location of required identification.
- C. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.5 VALVE TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
 - 1. Valve-Tag Size and Shape:
 - a. Chilled Water: 2 inches round.
 - b. Condenser Water: 2 inches round.
 - c. Refrigerant: 2 inches round.
 - d. Hot Water: 2 inches round.
 - e. Gas: 1-1/2 inches, round.
 - f. Low-Pressure Steam: 2 inches, round.
 - g. High-Pressure Steam: 2 inches, round.
 - h. Steam Condensate: 2 inches, round.
 - 2. Valve-Tag Color:
 - a. Chilled Water: Natural.
 - b. Condenser Water: Natural.

- c. Refrigerant: Natural.
- d. Hot Water: Natural.
- e. Gas: Natural.
- f. Low-Pressure Steam: Natural.
- g. High-Pressure Steam: Natural.
- h. Steam Condensate: Natural.
- 3. Letter Color:
 - a. Chilled Water: Black.
 - b. Condenser Water: Black.
 - c. Refrigerant: Black.
 - d. Hot Water: Black.
 - e. Gas: Black.
 - f. Low-Pressure Steam: Black.
 - g. High-Pressure Steam: Black.
 - h. Steam Condensate: Black.

3.6 WARNING-TAG INSTALLATION

Write required message on, and attach warning tags to, equipment and other items where required.

3.7 OWNER VERIFICATION

A. All tags - color identification of all systems shall be reviewed with the Owner prior to release of shop drawings.

END OF SECTION 23 0553

SECTION 23 0593 TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. General: The Owner will select a test and balance agency (herein referred to as the T&B Agency) and pay for the services of the T&B Agency for system and equipment performance verification.
- C. Definition of Terms:
 - a. "Contractor" shall refer to the General Contractor.

1.2 SUMMARY

- A. Section Includes:
 - 1. Balancing Air Systems:
 - a. Constant-volume air systems.
 - b. Variable-air-volume systems.
 - 2. Balancing Hydronic Piping Systems:
 - a. Constant-flow hydronic systems.
 - b. Variable-flow hydronic systems.
 - c. Primary-secondary hydronic systems.
 - d. Primary variable flow hydronic system.

1.3 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TABB: Testing, Adjusting, and Balancing Bureau.
- E. TAB Specialist: An entity engaged to perform TAB Work.

1.4 SUBMITTALS

- A. LEED Submittal:
 - 1. Air-Balance Report for LEED Prerequisite EQ 1: Documentation of work performed for ASHRAE 62.1-2004, Section 7.2.2 "Air Balancing."
- B. Qualification Data: Within 45 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

- C. Contract Documents Examination Report: Within 45 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.
- D. Strategies and Procedures Plan: Within 90 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- E. Certified TAB reports.
- F. Sample report forms.
- G. Instrument calibration reports, to include the following:
 - 1. Instrument type and make.
 - 2. Serial number.
 - 3. Application.
 - 4. Dates of use.
 - 5. Dates of calibration.

1.5 QUALITY ASSURANCE

- A. TAB Contractor Qualifications: Owner shall engage a TAB entity certified by NEBB.
 - 1. TAB Field Supervisor: Employee of the TAB contractor and certified by NEBB.
 - 2. TAB Technician: Employee of the TAB contractor and who is certified by NEBB as a TAB technician.
- B. TAB Conference: Meet with Architect, Owner, Construction Manager and Commissioning Authority on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.
 - 1. Agenda Items:
 - a. The Contract Documents examination report.
 - b. The TAB plan.
 - c. Coordination and cooperation of trades and subcontractors.
 - d. Coordination of documentation and communication flow.
- C. Certify TAB field data reports and perform the following:
 - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 - 2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.
 - 3. Test methods of determining airtightness of building using an orifice blower door.
- D. TAB Report Forms: Use standard TAB contractor's forms approved by Architect and Commissioning Authority.
- E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

1.6 **PROJECT CONDITIONS**

- A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.
- B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

- A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.
- B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
- B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Division 23 Section "Metal Ducts" and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.
- F. Examine equipment performance data including fan and pump curves.
 - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- J. Examine terminal units; such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
- K. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.
- L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- N. Examine system pumps to ensure absence of entrained air in the suction piping.
- O. Examine operating safety interlocks and controls on HVAC equipment.
- P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Complete system-readiness checks and prepare reports. Verify the following:
 - 1. Permanent electrical-power wiring is complete.
 - 2. Hydronic systems are filled, clean, and free of air.
 - 3. Automatic temperature-control systems are operational.
 - 4. Equipment and duct access doors are securely closed.
 - 5. Balance, smoke, and fire dampers are open.
 - 6. Isolating and balancing valves are open and control valves are operational.
 - 7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
 - 8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.
 - 1. Comply with requirements in ASHRAE 62.1-2004, Section 7.2.2, "Air Balancing."
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

- 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
- 2. After testing and balancing, install test ports and duct access doors that comply with requirements in Division 23 Section "Air Duct Accessories."
- 3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC Insulation."
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling-unit components.
- L. Verify that air duct system is sealed as specified in Division 23 Section "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure total airflow:
 - a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.

- 2. Measure fan static pressures as follows to determine actual static pressure:
 - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
- 3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment:
 - a. Report the cleanliness status of filters and the time static pressures are measured.
- 4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
- 5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
- 6. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Division 23 Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
- 7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
- 1. Measure airflow of submain and branch ducts:
 - a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
- 2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
- 3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

- C. Measure air outlets and inlets without making adjustments.
- 1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
- 1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
- 2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
 - 1. Open all manual valves for maximum flow.
 - 2. Check liquid level in expansion tank.
 - 3. Check makeup water-station pressure gage for adequate pressure for highest vent.
 - 4. Check flow-control valves for specified sequence of operation, and set at indicated flow.
 - 5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
 - 6. Set system controls so automatic valves are wide open to heat exchangers.
 - 7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
 - 8. Check air vents for a forceful liquid flow exiting from vents when manually operated.
- D. Systems installed with pressure-independent control valves shall require verification of flow for 25% of the total number of installed valves, unless otherwise indicated herein. Exact locations of tested valves shall be coordinated with the Engineer and Commissioning Authority.

3.7 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

- A. Measure water flow at pumps. Use the following procedures except for positivedisplacement pumps:
 - 1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.

- a. If impeller sizes must be adjusted to achieve pump performance, obtain approval from Architect and comply with requirements in Division 23 Section "Hydronic Pumps."
- 2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
 - a. Monitor motor performance during procedures and do not operate motors in overload conditions.
- 3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
- 4. Report flow rates that are not within plus or minus 10 percent of design.
- B. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.
- C. Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.
- D. Set calibrated balancing valves, if installed, at calculated presettings.
- E. Measure flow at all stations and adjust, where necessary, to obtain first balance.
 - 1. System components that have Cv rating or an accurately cataloged flow-pressuredrop relationship may be used as a flow-indicating device.
- F. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.
- G. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
 - 1. Determine the balancing station with the highest percentage over indicated flow.
 - 2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
 - 3. Record settings and mark balancing devices.
- H. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.
- I. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.
- J. Check settings and operation of each safety valve. Record settings.

3.8 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.9 PROCEDURES FOR HEAT EXCHANGERS

- A. Measure water flow through all circuits.
- B. Adjust water flow to within specified tolerances.
- C. Measure inlet and outlet water temperatures.
- D. Check settings and operation of safety and relief valves. Record settings.

3.10 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 - 1. Manufacturer's name, model number, and serial number.
 - 2. Motor horsepower rating.
 - 3. Motor rpm.
 - 4. Efficiency rating.
 - 5. Nameplate and measured voltage, each phase.
 - 6. Nameplate and measured amperage, each phase.
 - 7. Starter thermal-protection-element rating.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.11 PROCEDURES FOR CHILLERS

- A. Balance water flow through each evaporator and condenser to within specified tolerances of indicated flow with all pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:
 - 1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
 - 2. For water-cooled chillers, condenser-water entering and leaving temperatures, pressure drop, and water flow.
 - 3. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
 - 4. Power factor if factory-installed instrumentation is furnished for measuring kilowatts.
 - 5. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts.
 - 6. Capacity: Calculate in tons of cooling.

7. For air-cooled chillers, verify condenser-fan rotation and record fan and motor data including number of fans and entering- and leaving-air temperatures.

3.12 PROCEDURES FOR COOLING TOWERS

- A. Shut off makeup water for the duration of the test, and verify that makeup and blowdown systems are fully operational after tests and before leaving the equipment. Perform the following tests and record the results:
 - 1. Measure condenser-water flow to each cell of the cooling tower.
 - 2. Measure entering- and leaving-water temperatures.
 - 3. Measure wet- and dry-bulb temperatures of entering air.
 - 4. Measure wet- and dry-bulb temperatures of leaving air.
 - 5. Measure condenser-water flow rate recirculating through the cooling tower.
 - 6. Measure cooling-tower spray pump discharge pressure.
 - 7. Adjust water level and feed rate of makeup water system.
 - 8. Measure flow through bypass.

3.13 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record compressor data.

3.14 PROCEDURES FOR BOILERS

- A. Hydronic Boilers: Measure and record entering- and leaving-water temperatures and water flow.
- B. Steam Boilers: Measure and record entering-water temperature and flow and leavingsteam pressure, temperature, and flow.

3.15 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Measure, adjust, and record the following data for each water coil:
 - 1. Entering and leaving water temperature.
 - 2. Water flow rate.
 - 3. Water pressure drop.
 - 4. Dry-bulb temperature of entering and leaving air.
 - 5. Wet-bulb temperature of entering and leaving air for cooling coils.
 - 6. Airflow.
 - 7. Air pressure drop.
- B. Measure, adjust, and record the following data for each electric heating coil:
 - 1. Nameplate data.
 - 2. Airflow.
 - 3. Entering- and leaving-air temperature at full load.
 - 4. Voltage and amperage input of each phase at full load and at each incremental stage.
 - 5. Calculated kilowatt at full load.
 - 6. Fuse or circuit-breaker rating for overload protection.

- C. Measure, adjust, and record the following data for each steam coil:
 - 1. Dry-bulb temperature of entering and leaving air.
 - 2. Airflow.
 - 3. Air pressure drop.
 - 4. Inlet steam pressure.
- D. Measure, adjust, and record the following data for each refrigerant coil:
 - 1. Dry-bulb temperature of entering and leaving air.
 - 2. Wet-bulb temperature of entering and leaving air.
 - 3. Airflow.
 - 4. Air pressure drop.
 - 5. Refrigerant suction pressure and temperature.

3.16 TOLERANCES

- A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
 - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
 - 2. Air Outlets and Inlets: Plus or minus 10 percent.
 - 3. Heating-Water Flow Rate: Plus or minus 10 percent.
 - 4. Cooling-Water Flow Rate: Plus or minus 10 percent.

3.17 REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
- B. Status Reports: Prepare monthly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.18 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
 - 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 - 2. Include a list of instruments used for procedures, along with proof of calibration.
- B. Final Report Contents: In addition to certified field-report data, include the following:
 - 1. Pump curves.
 - 2. Fan curves.
 - 3. Manufacturers' test data.
 - 4. Field test reports prepared by system and equipment installers.
- 5. Other information relative to equipment performance; do not include Shop Drawings and product data.
- C. General Report Data: In addition to form titles and entries, include the following data:
 - 1. Title page.
 - 2. Name and address of the TAB contractor.
 - 3. Project name.
 - 4. Project location.
 - 5. Architect's name and address.
 - 6. Engineer's name and address.
 - 7. Contractor's name and address.
 - 8. Report date.
 - 9. Signature of TAB supervisor who certifies the report.
 - 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 - 11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 - 12. Nomenclature sheets for each item of equipment.
 - 13. Data for terminal units, including manufacturer's name, type, size, and fittings.
 - 14. Notes to explain why certain final data in the body of reports vary from indicated values.
 - 15. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings including settings and percentage of maximum pitch diameter.
 - f. Settings for supply-air, static-pressure controller.
 - g. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
 - 1. Quantities of outdoor, supply, return, and exhaust airflows.
 - 2. Water and steam flow rates.
 - 3. Duct, outlet, and inlet sizes.
 - 4. Pipe and valve sizes and locations.
 - 5. Terminal units.
 - 6. Balancing stations.
 - 7. Position of balancing devices.

- E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
 - 1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches, and bore.
 - i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - j. Number, make, and size of belts.
 - k. Number, type, and size of filters.
 - 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - 3. Test Data (Indicated and Actual Values):
 - a. Total air flow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Filter static-pressure differential in inches wg.
 - f. Preheat-coil static-pressure differential in inches wg.
 - g. Cooling-coil static-pressure differential in inches wg.
 - h. Heating-coil static-pressure differential in inches wg.
 - i. Outdoor airflow in cfm.
 - j. Return airflow in cfm.
 - k. Outdoor-air damper position.
 - I. Return-air damper position.
 - m. Vortex damper position.
- F. Apparatus-Coil Test Reports:
 - 1. Coil Data:
 - a. System identification.
 - b. Location.
 - c. Coil type.
 - d. Number of rows.
 - e. Fin spacing in fins per inch o.c.
 - f. Make and model number.
 - g. Face area in sq. ft..
 - h. Tube size in NPS.

- i. Tube and fin materials.
- j. Circuiting arrangement.
- 2. Test Data (Indicated and Actual Values):
 - a. Air flow rate in cfm.
 - b. Average face velocity in fpm.
 - c. Air pressure drop in inches wg.
 - d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
 - e. Return-air, wet- and dry-bulb temperatures in deg F.
 - f. Entering-air, wet- and dry-bulb temperatures in deg F.
 - g. Leaving-air, wet- and dry-bulb temperatures in deg F.
 - h. Water flow rate in gpm.
 - i. Water pressure differential in feet of head or psig.
 - j. Entering-water temperature in deg F.
 - k. Leaving-water temperature in deg F.
 - I. Refrigerant expansion valve and refrigerant types.
 - m. Refrigerant suction pressure in psig.
 - n. Refrigerant suction temperature in deg F.
 - o. Inlet steam pressure in psig.
- G. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
 - 1. Unit Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Fuel type in input data.
 - g. Output capacity in Btu/h.
 - h. Ignition type.
 - i. Burner-control types.
 - j. Motor horsepower and rpm.
 - k. Motor volts, phase, and hertz.
 - I. Motor full-load amperage and service factor.
 - m. Sheave make, size in inches (mm), and bore.
 - n. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - 2. Test Data (Indicated and Actual Values):
 - a. Total air flow rate in cfm.
 - b. Entering-air temperature in deg F.
 - c. Leaving-air temperature in deg F.
 - d. Air temperature differential in deg F.
 - e. Entering-air static pressure in inches wg.
 - f. Leaving-air static pressure in inches wg.
 - g. Air static-pressure differential in inches wg.
 - h. Low-fire fuel input in Btu/h.
 - i. High-fire fuel input in Btu/h.
 - j. Manifold pressure in psig.
 - k. High-temperature-limit setting in deg F.

Project No. 121505 Testing, Adjusting, and Balancing for HVAC **TLC** Engineering Solutions Section 23 0593 - 14

- I. Operating set point in Btu/h.
- m. Motor voltage at each connection.
- n. Motor amperage for each phase.
- o. Heating value of fuel in Btu/h.
- H. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:
 - 1. Unit Data:
 - a. System identification.
 - b. Location.
 - c. Coil identification.
 - d. Capacity in Btu/h.
 - e. Number of stages.
 - f. Connected volts, phase, and hertz.
 - g. Rated amperage.
 - h. Air flow rate in cfm.
 - i. Face area in sq. ft..
 - j. Minimum face velocity in fpm.
 - 2. Test Data (Indicated and Actual Values):
 - a. Heat output in Btu/h.
 - b. Air flow rate in cfm.
 - c. Air velocity in fpm.
 - d. Entering-air temperature in deg F.
 - e. Leaving-air temperature in deg F.
 - f. Voltage at each connection.
 - g. Amperage for each phase.
- I. Fan Test Reports: For supply, return, and exhaust fans, include the following:
 - 1. Fan Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches, and bore.
 - h. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - g. Number, make, and size of belts.

- 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Suction static pressure in inches wg.
- J. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
 - 1. Report Data:
 - a. System and air-handling-unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F.
 - d. Duct static pressure in inches wg.
 - e. Duct size in inches.
 - f. Duct area in sq. ft..
 - g. Indicated air flow rate in cfm.
 - h. Indicated velocity in fpm.
 - i. Actual air flow rate in cfm.
 - j. Actual average velocity in fpm.
 - k. Barometric pressure in psig.
- K. Air-Terminal-Device Reports:
 - 1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Apparatus used for test.
 - d. Area served.
 - e. Make.
 - f. Number from system diagram.
 - g. Type and model number.
 - h. Size.
 - i. Effective area in sq. ft..
 - 2. Test Data (Indicated and Actual Values):
 - a. Air flow rate in cfm.
 - b. Air velocity in fpm.
 - c. Preliminary air flow rate as needed in cfm.
 - d. Preliminary velocity as needed in fpm.
 - e. Final air flow rate in cfm.
 - f. Final velocity in fpm.
 - g. Space temperature in deg F.
- L. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
 - 1. Unit Data:
 - a. System and air-handling-unit identification.
 - b. Location and zone.

- c. Room or riser served.
- d. Coil make and size.
- e. Flowmeter type.
- 2. Test Data (Indicated and Actual Values):
 - a. Air flow rate in cfm.
 - b. Entering-water temperature in deg F.
 - c. Leaving-water temperature in deg F.
 - d. Water pressure drop in feet of head or psig.
 - e. Entering-air temperature in deg F.
 - f. Leaving-air temperature in deg F.
- M. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:
 - 1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Service.
 - d. Make and size.
 - e. Model number and serial number.
 - f. Water flow rate in gpm.
 - g. Water pressure differential in feet of head or psig.
 - h. Required net positive suction head in feet of head or psig.
 - i. Pump rpm.
 - j. Impeller diameter in inches.
 - k. Motor make and frame size.
 - I. Motor horsepower and rpm.
 - m. Voltage at each connection.
 - n. Amperage for each phase.
 - o. Full-load amperage and service factor.
 - p. Seal type.
 - 2. Test Data (Indicated and Actual Values):
 - a. Static head in feet of head or psig.
 - b. Pump shutoff pressure in feet of head or psig.
 - c. Actual impeller size in inches.
 - d. Full-open flow rate in gpm.
 - e. Full-open pressure in feet of head or psig.
 - f. Final discharge pressure in feet of head or psig.
 - g. Final suction pressure in feet of head or psig.
 - h. Final total pressure in feet of head or psig.
 - i. Final water flow rate in gpm.
 - j. Voltage at each connection.
 - k. Amperage for each phase.
- N. Instrument Calibration Reports:
 - 1. Report Data:
 - a. Instrument type and make.
 - b. Serial number.

- c. Application.
- d. Dates of use.
- e. Dates of calibration.

3.19 INSPECTIONS

- A. Initial Inspection:
 - 1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
 - 2. Check the following for each system:
 - a. Measure airflow of at least 10 percent of air outlets.
 - b. Measure water flow of at least 5 percent of terminals.
 - c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
 - d. Verify that balancing devices are marked with final balance position.
 - e. Note deviations from the Contract Documents in the final report.
- B. Final Inspection:
 - Report Availability: One copy of the final Test and Balance Report shall be made available at the project site for the AHCA final survey. This final report shall be typewritten and submitted to the Architect prior to the final survey with sufficient time for review, comment, correction of report, additional testing as necessary, follow-up review, and acceptable signature by the Architect. The Test and Balance Report shall include differential pressure testing of each duct smoke detector, verifying that each reading falls within the manufacturer's acceptable tolerance.
 - 2. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Architect.
 - 3. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Architect.
 - 4. Architect shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
 - If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
 - 6. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
- C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

- 1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
- 2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.
- 3. Final Completion: AHCA: Final completion certificate and payment shall be withheld pending receipt of the letter from AHCA which details the final survey deficiency comments and does not indicate that the test and balance data requires further submission and review.
- D. Prepare test and inspection reports.

3.20 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 23 0593

SECTION 23 0700 HVAC INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Insulation Materials:
 - a. Cellular glass.
 - b. Flexible elastomeric.
 - c. Mineral fiber.
 - 2. Adhesives.
 - 3. Mastics.
 - 4. Lagging adhesives.
 - 5. Sealants.
 - 6. Factory-applied jackets.
 - 7. Field-applied fabric-reinforcing mesh.
 - 8. Field-applied cloths.
 - 9. Field-applied jackets.
 - 10. Securements.
 - 11. Corner angles.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).
- B. Shop Drawings:
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail attachment and covering of heat tracing inside insulation.
 - 3. Detail insulation application at pipe expansion joints for each type of insulation.
 - 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 5. Detail removable insulation at piping specialties, equipment connections, and access panels.
 - 6. Detail application of field-applied jackets.
 - 7. Detail application at linkages of control devices.
 - 8. Detail field application for each equipment type.
- C. Qualification Data: For qualified Installer.
- D. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation

Project No. 121505 HVAC Insulation Section 23 0700 - 1 materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

E. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smokedeveloped index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smokedeveloped index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.
- D. Insulation type and location shall be reviewed prior to submittal for all Aquatherm type piping systems.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cell-U-Foam Corporation; Ultra-CUF.
 - b. Pittsburgh Corning Corporation; Foamglas Super K.
 - 2. Block Insulation: ASTM C 552, Type I.
 - 3. Special-Shaped Insulation: ASTM C 552, Type III.
 - 4. Board Insulation: ASTM C 552, Type IV.
 - 5. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
 - 6. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C 552, Type II, Class 2.
 - 7. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- G. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Aeroflex USA Inc.; Aerocel.
 - b. Armacell LLC; AP Armaflex.
 - c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.
- H. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corp.; Duct Wrap.
 - b. Johns Manville; Microlite.
 - c. Knauf Insulation; Duct Wrap.
 - d. Manson Insulation Inc.; Alley Wrap.

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- e. Owens Corning; All-Service Duct Wrap.
- I. Mineral-Fiber, Preformed Pipe Insulation:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Fibrex Insulations Inc.; Coreplus 1200.
 - b. Johns Manville; Micro-Lok.
 - c. Knauf Insulation; 1000 Pipe Insulation.
 - d. Manson Insulation Inc.; Alley-K.
 - e. Owens Corning; Fiberglas Pipe Insulation.
 - Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Cellular-Glass Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
 - 1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; CP-96. b.Foster Products Corporation, H. B. Fuller Company; 81-33.

- 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Aeroflex USA Inc.; Aeroseal.
 - b. Armacell LCC; 520 Adhesive.
 - c. Foster Products Corporation, H. B. Fuller Company; 85-75.
 - d. RBX Corporation; Rubatex Contact Adhesive.
 - 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
 - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
 - d. Marathon Industries, Inc.; 225.

- e. Mon-Eco Industries, Inc.; 22-25.
- 2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- E. Polystyrene Adhesive: Solvent- or water-based, synthetic resin adhesive with a service temperature range of minus 20 to plus 140 deg F.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-96.
 - b. Foster Products Corporation, H. B. Fuller Company; 97-13.
- F. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
 - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
 - d. Marathon Industries, Inc.; 225.
 - e. Mon-Eco Industries, Inc.; 22-25.
 - 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- G. PVC Jacket Adhesive: Compatible with PVC jacket.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Chemical Company (The); 739, Dow Silicone.
 - b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
 - c. P.I.C. Plastics, Inc.; Welding Adhesive.
 - d. Speedline Corporation; Speedline Vinyl Adhesive.
 - 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
 - 1. For indoor applications, use mastics that have a VOC content of g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
 - 1. Products: Subject to compliance with requirements, provide one of the following: a. Childers Products, Division of ITW; CP-35.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-90.
 - c. ITW TACC, Division of Illinois Tool Works; CB-50.
 - d. Marathon Industries, Inc.; 590.

- e. Mon-Eco Industries, Inc.; 55-40.
- f. Vimasco Corporation; 749.
- 2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
- 3. Service Temperature Range: Minus 20 to plus 180 deg F.
- 4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
- 5. Color: White.
- C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-30.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-35.
 - c. ITW TACC, Division of Illinois Tool Works; CB-25.
 - d. Marathon Industries, Inc.; 501.
 - e. Mon-Eco Industries, Inc.; 55-10.
 - 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
 - 3. Service Temperature Range: 0 to 180 deg F.
 - 4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
 - 5. Color: White.
- D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; Encacel.
 - b. Foster Products Corporation, H. B. Fuller Company; 60-95/60-96.
 - c. Marathon Industries, Inc.; 570.
 - d. Mon-Eco Industries, Inc.; 55-70.
 - 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
 - 3. Service Temperature Range: Minus 50 to plus 220 deg F.
 - 4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
 - 5. Color: White.
- E. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-10.
 - b. Foster Products Corporation, H. B. Fuller Company; 35-00.
 - c. ITW TACC, Division of Illinois Tool Works; CB-05/15.
 - d. Marathon Industries, Inc.; 550.
 - e. Mon-Eco Industries, Inc.; 55-50.
 - f. Vimasco Corporation; WC-1/WC-5.
 - 2. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
 - 3. Service Temperature Range: Minus 20 to plus 200 deg F.

- 4. Solids Content: 63 percent by volume and 73 percent by weight.
- 5. Color: White.

2.4 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
 - 1. For indoor applications, use lagging adhesives that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-52.
 - b. Foster Products Corporation, H. B. Fuller Company; 81-42.
 - c. Marathon Industries, Inc.; 130.
 - d. Mon-Eco Industries, Inc.; 11-30.
 - e. Vimasco Corporation; 136.
 - 3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation.
 - 4. Service Temperature Range: Minus 50 to plus 180 deg F.
 - 5. Color: White.

2.5 SEALANTS

- A. Joint Sealants:
 - 1. Joint Sealants for Cellular-Glass, Phenolic, and Polyisocyanurate Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-76.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-45.
 - c. Marathon Industries, Inc.; 405.
 - d. Mon-Eco Industries, Inc.; 44-05.
 - e. Pittsburgh Corning Corporation; Pittseal 444.
 - f. Vimasco Corporation; 750.
 - 2. Joint Sealants for Polystyrene Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-70.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-45/30-46.
 - c. Marathon Industries, Inc.; 405.
 - d. Mon-Eco Industries, Inc.; 44-05.
 - e. Vimasco Corporation; 750.
 - 3. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 4. Permanently flexible, elastomeric sealant.
 - 5. Service Temperature Range: Minus 100 to plus 300 deg F.
 - 6. Color: White or gray.
 - 7. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

- B. FSK and Metal Jacket Flashing Sealants:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-76-8.
 - b. Foster Products Corporation, H. B. Fuller Company; 95-44.
 - c. Marathon Industries, Inc.; 405.
 - d. Mon-Eco Industries, Inc.; 44-05.
 - e. Vimasco Corporation; 750.
 - 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 3. Fire- and water-resistant, flexible, elastomeric sealant.
 - 4. Service Temperature Range: Minus 40 to plus 250 deg F.
 - 5. Color: Aluminum.
 - 6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-76.
 - 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 3. Fire- and water-resistant, flexible, elastomeric sealant.
 - 4. Service Temperature Range: Minus 40 to plus 250 deg F.
 - 5. Color: White.
 - 6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.6 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
 - 1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 - 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
 - 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
 - 4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
 - 5. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
 - a. Products: Subject to compliance with requirements, provide one of the following:

- 1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
- 6. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permanence at 0.01 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
- 7. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylicbased adhesive covered by a removable protective strip.
 - a. Products: Subject to compliance with requirements, provide the following:
 - 1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
- 8. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.7 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Glass-Fiber Fabric for Pipe Insulation: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch for covering pipe and pipe fittings.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Vimasco Corporation; Elastafab 894.
- B. Woven Glass-Fiber Fabric for Duct and Equipment Insulation: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. inch for covering equipment.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; Chil-Glas No. 5.
- C. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch, in a Leno weave, for duct, equipment, and pipe.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Foster Products Corporation, H. B. Fuller Company; Mast-A-Fab.
 - b. Vimasco Corporation; Elastafab 894.

2.8 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd..

- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59.

2.9 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Johns Manville; Zeston.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto PVC Corporation; LoSmoke.
 - d. Speedline Corporation; SmokeSafe.
 - 2. Adhesive: As recommended by jacket material manufacturer.
 - 3. Color: White.
 - 4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
 - 5. Factory-fabricated tank heads and tank side panels.
- D. Metal Jacket:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; Metal Jacketing Systems.
 - b. PABCO Metals Corporation; Surefit.
 - c. RPR Products, Inc.; Insul-Mate.
 - 2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.
 - a. Factory cut and rolled to size.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper
 - d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
 - e. Factory-Fabricated Fitting Covers:

- 1) Same material, finish, and thickness as jacket.
- 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
- 3) Tee covers.
- 4) Flange and union covers.
- 5) End caps.
- 6) Beveled collars.
- 7) Valve covers.
- 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
- 3. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.
 - a. Factory cut and rolled to size.
 - b. Material, finish, and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
 - d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
 - e. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricates fitting covers only if factory-fabricated fitting covers are not available.
- E. Underground Direct-Buried Jacket: 125-mil- thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Pittsburgh Corning Corporation; Pittwrap.
 - b. Polyguard; Insulrap No Torch 125.
- F. Self-Adhesive Outdoor Jacket: 60-mil- thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with white aluminum-foil facing.
 - Products: Subject to compliance with requirements, provide one of the following:
 a. Polyguard; Alumaguard 60.
- G. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Chemical Company (The), Saran 540 Vapor Retarder Film.
- H. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
 - 1. Products: Subject to compliance with requirements, provide one of the following: a. Dow Chemical Company (The), Saran 560 Vapor Retarder Film.
- I. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

2.10 SECUREMENTS

- A. Bands:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products; Bands.
 - b. PABCO Metals Corporation; Bands.
 - c. RPR Products, Inc.; Bands.
 - 2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch thick, 1/2 inch wide with wing or closed seal.
 - 3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing or closed seal.
 - 4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.
- B. Insulation Pins and Hangers:
 - 1. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.
 - 2) GEMCO; Perforated Base.
 - 3) Midwest Fasteners, Inc.; Spindle.
 - b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.

- c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106inch- diameter shank, length to suit depth of insulation indicated.
- d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
- 2. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) GEMCO; Nylon Hangers.
 - 2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.
 - b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
 - c. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
 - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
- 3. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) AGM Industries, Inc.; RC-150.
 - 2) GEMCO; R-150.
 - 3) Midwest Fasteners, Inc.; WA-150.
 - 4) Nelson Stud Welding; Speed Clips.
 - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
- 4. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016inch- thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) GEMCO.
 - 2) Midwest Fasteners, Inc.

- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.
- D. Wire: 0.080-inch nickel-copper alloy.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. C & F Wire.
 - b. Childers Products.
 - c. PABCO Metals Corporation.
 - d. RPR Products, Inc.

2.11 CORNER ANGLES

- A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.
- B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.
- C. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
 - 1. Verify that systems and equipment to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
 - 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 - 1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
 - 2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above ambient services, do not install insulation to the following:
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.
 - 4. Manholes.
 - 5. Handholes.
 - 6. Cleanouts.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.

- 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 - 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
 - 1. Comply with requirements in Division 07 Section "Penetration Firestopping"irestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
 - 1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
 - 2. Pipe: Install insulation continuously through floor penetrations.
 - 3. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.5 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

- A. Mineral Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.
 - 1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of tank and vessel surfaces.

- 2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
- 3. Protect exposed corners with secured corner angles.
- 4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
 - a. Do not weld anchor pins to ASME-labeled pressure vessels.
 - b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
 - c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
 - d. Do not overcompress insulation during installation.
 - e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
 - f. Impale insulation over anchor pins and attach speed washers.
 - g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
- 5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
- 6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
- 7. Stagger joints between insulation layers at least 3 inches.
- 8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
- 9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
- 10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.
- B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
 - 1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.

- 2. Seal longitudinal seams and end joints.
- C. Insulation Installation on Pumps:
 - 1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch- diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
 - 2. Fabricate boxes from aluminum at least 0.050 inch thick.
 - 3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.6 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 - 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
 - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 - 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 - 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 - 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.

Project No. 121505 HVAC Insulation Section 23 0700 - 19

- 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
- 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
- 8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
- 9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
 - 1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 - 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 - 3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
 - 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 - 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.7 CALCIUM SILICATE INSULATION INSTALLATION

A. Insulation Installation on Boiler Breechings and Ducts:

- 1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation material.
- 2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.
- 3. On exposed applications without metal jacket, finish insulation surface with a skim coat of mineral-fiber, hydraulic-setting cement. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth. Thin finish coat to achieve smooth, uniform finish.
- B. Insulation Installation on Straight Pipes and Tubes:
 - 1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.
 - 2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.
 - 3. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.
- C. Insulation Installation on Pipe Flanges:
 - 1. Install preformed pipe insulation to outer diameter of pipe flange.
 - 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 - 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.
 - 4. Finish flange insulation same as pipe insulation.
- D. Insulation Installation on Pipe Fittings and Elbows:
 - 1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
 - 2. When preformed insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.
 - 3. Finish fittings insulation same as pipe insulation.
- E. Insulation Installation on Valves and Pipe Specialties:

- 1. Install mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
- 2. Install insulation to flanges as specified for flange insulation application.
- 3. Finish valve and specialty insulation same as pipe insulation.

3.8 CELLULAR-GLASS INSULATION INSTALLATION

- A. Insulation Installation on Straight Pipes and Tubes:
 - 1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 - 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 - 3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches o.c.
 - 4. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- B. Insulation Installation on Pipe Flanges:
 - 1. Install preformed pipe insulation to outer diameter of pipe flange.
 - 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 - 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
 - 4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.
- C. Insulation Installation on Pipe Fittings and Elbows:
 - 1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
 - 2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.
- D. Insulation Installation on Valves and Pipe Specialties:
 - 1. Install preformed sections of cellular-glass insulation to valve body.
 - 2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

3. Install insulation to flanges as specified for flange insulation application.

3.9 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

- A. Seal longitudinal seams and end joints with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
 - 1. Install pipe insulation to outer diameter of pipe flange.
 - 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 - 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
 - 4. Secure insulation to flanges and seal seams with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
 - 1. Install mitered sections of pipe insulation.
 - 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
 - 1. Install preformed valve covers manufactured of same material as pipe insulation when available.
 - 2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - 3. Install insulation to flanges as specified for flange insulation application.
 - 4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.10 MINERAL-FIBER INSULATION INSTALLATION

- A. Insulation Installation on Straight Pipes and Tubes:
 - 1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 - 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

- 3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
- 4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- B. Insulation Installation on Pipe Flanges:
 - 1. Install preformed pipe insulation to outer diameter of pipe flange.
 - 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 - 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
 - 4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.
- C. Insulation Installation on Pipe Fittings and Elbows:
 - 1. Install preformed sections of same material as straight segments of pipe insulation when available.
 - 2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.
- D. Insulation Installation on Valves and Pipe Specialties:
 - 1. Install preformed sections of same material as straight segments of pipe insulation when available.
 - 2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
 - 3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - 4. Install insulation to flanges as specified for flange insulation application.
- E. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
 - 1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.
 - 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

- 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
- 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Zshaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.
- 5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
- 6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
- 7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.
- F. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

- 1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.
- 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
- 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
- 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vaporbarrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Zshaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.
- 5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
- 6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.11 PHENOLIC INSULATION INSTALLATION

- A. General Installation Requirements:
 - 1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.
 - 2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with 0.062-inch wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.
- B. Insulation Installation on Straight Pipes and Tubes:
 - 1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 - 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 - 3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches o.c.
 - 4. For insulation with factory-applied jackets with vapor retarders on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- C. Insulation Installation on Pipe Flanges:
 - 1. Install preformed pipe insulation to outer diameter of pipe flange.
 - 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 - 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.
- D. Insulation Installation on Pipe Fittings and Elbows:
 - 1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
- E. Insulation Installation on Valves and Pipe Specialties:
 - 1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
 - 2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - 3. Install insulation to flanges as specified for flange insulation application.

3.12 POLYISOCYANURATE INSULATION INSTALLATION

- A. Insulation Installation on Straight Pipes and Tubes:
 - 1. Secure each layer of insulation to pipe with tape or bands and tighten without deforming insulation materials. Orient longitudinal joints between half sections in 3 and 9 o'clock positions on the pipe.
 - 2. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs but secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
 - 3. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.
- B. Insulation Installation on Pipe Flanges:
 - 1. Install preformed pipe insulation to outer diameter of pipe flange.
 - 2. Make width of insulation section same as overall width of flange and bolts, same thickness of adjacent pipe insulation, not to exceed 1-1/2-inch thickness.
 - 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyisocyanurate block insulation of same thickness as pipe insulation.
- C. Insulation Installation on Fittings and Elbows:
 - 1. Install preformed sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
- D. Insulation Installation on Valves and Pipe Specialties:
 - 1. Install preformed sections of polyisocyanurate insulation to valve body.
 - 2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - 3. Install insulation to flanges as specified for flange insulation application.

3.13 POLYOLEFIN INSULATION INSTALLATION

- A. Insulation Installation on Straight Pipes and Tubes:
 - 1. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
 - 1. Install pipe insulation to outer diameter of pipe flange.
- 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
- 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as pipe insulation.
- 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
 - 1. Install mitered sections of polyolefin pipe insulation.
 - 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
 - 1. Install cut sections of polyolefin pipe and sheet insulation to valve body.
 - 2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - 3. Install insulation to flanges as specified for flange insulation application.
 - 4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.14 POLYSTYRENE INSULATION INSTALLATION

- A. Insulation Installation on Straight Pipes and Tubes:
 - 1. Secure each layer of insulation with tape or bands and tighten bands without deforming insulation materials. Orient longitudinal joints between half sections in 3 and 9 o'clock positions on the pipe.
 - 2. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs but secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
 - 3. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.
- B. Insulation Installation on Pipe Flanges:
 - 1. Install preformed pipe insulation to outer diameter of pipe flange.
 - 2. Make width of insulation section same as overall width of flange and bolts, same thickness of adjacent pipe insulation, not to exceed 1-1/2-inch thickness.

- 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polystyrene block insulation of same thickness as pipe insulation.
- C. Insulation Installation on Pipe Fittings and Elbows:
 - 1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
- D. Insulation Installation on Valves and Pipe Specialties:
 - 1. Install preformed section of polystyrene insulation to valve body.
 - 2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - 3. Install insulation to flanges as specified for flange insulation application.

3.15 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
 - 1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
 - 2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
 - 3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where FSK jackets are indicated, install as follows:
 - 1. Draw jacket material smooth and tight.
 - 2. Install lap or joint strips with same material as jacket.
 - 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 - 4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
 - 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
 - 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.
- E. Where PVDC jackets are indicated, install as follows:
 - 1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
 - 2. Wrap factory-presized jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an

approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.

- 3. Continuous jacket can be spiral wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
- 4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2-inch-circumference limit allows for 2-inch- overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
- 5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.16 FIRE-RATED INSULATION SYSTEM INSTALLATION

- A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.
- B. Insulate duct access panels and doors to achieve same fire rating as duct.
- C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Division 07 Section "Penetration Firestopping."

3.17 FINISHES

- A. Duct, Equipment, and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.
 - 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

3.18 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.

- C. Tests and Inspections:
 - 1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.
 - 2. Inspect field-insulated equipment, randomly selected by Architect, by removing fieldapplied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
 - 3. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
- D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.19 DUCT INSULATION SCHEDULE, GENERAL

- A. Plenums and Ducts Requiring Insulation:
 - 1. Indoor, concealed supply and outdoor air.
 - 2. Indoor, exposed supply and outdoor air.
 - 3. Indoor, concealed return located in nonconditioned space.
 - 4. Indoor, exposed return located in nonconditioned space.
 - 5. Outdoor, concealed supply and return.
 - 6. Outdoor, exposed supply and return.
- B. Items Not Insulated:
 - 1. Factory-insulated flexible ducts.
 - 2. Factory-insulated plenums and casings.
 - 3. Flexible connectors.
 - 4. Vibration-control devices.
 - 5. Factory-insulated access panels and doors.

3.20 INDOOR DUCT INSULATION SCHEDULE

- A. Concealed, round and flat-oval, supply-air duct insulation shall be the following:
 - 1. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.
- B. Concealed, round and flat-oval, return-air duct insulation shall be the following:
 - 1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
- C. Concealed, round and flat-oval, outdoor-air duct insulation shall be the following:

- 1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
- D. Concealed, rectangular, supply-air duct insulation shall be the following:
 - 1. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.
- E. Concealed, rectangular, return-air duct insulation shall be the following:
 - 1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
- F. Concealed, rectangular, outdoor-air duct insulation shall be the following:
 - 1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
- G. Exposed, round and flat-oval, supply-air duct insulation shall be the following:
 - 1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
- H. Exposed, round and flat-oval, return-air duct insulation shall be the following:
 - 1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
- I. Exposed, round and flat-oval, outdoor-air duct insulation shall be the following:
 - 1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
- J. Exposed, rectangular, supply-air duct insulation in the Mechanical Rooms to 6 feet above finish floor, shall be the following:
 - 1. Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density.
- K. Exposed, rectangular, return-air duct insulation in the Mechanical Rooms to 6 feet above finish floor, shall be the following:
 - 1. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.
- L. Exposed, rectangular, outdoor-air duct insulation in the Mechanical Rooms to 6 feet above finish floor, shall be the following:
 - 1. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.
- M. Exposed, supply-air plenum insulation shall be the following:
 - 1. Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density.
- N. Exposed, return-air plenum insulation shall be the following:
 - 1. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.
- O. Exposed, outdoor-air plenum insulation shall be the following:
 - 1. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.

3.21 EQUIPMENT INSULATION SCHEDULE

- A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.
- B. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.
- C. Chillers: Insulate cold surfaces on chillers, including, but not limited to, evaporator bundles, heat-recovery bundles suction piping, compressor inlets, tube sheets, water boxes, and nozzles with one of the following:
 - 1. Cellular Glass: 2 inches thick.
 - 2. Flexible Elastomeric: 2 inches thick.
- D. Heat-exchanger (water-to-water for heating service) insulation shall be one of the following:
 - 1. Calcium Silicate: 3 inches thick.
 - 2. Mineral-Fiber Board: 3 inches thick and 2-lb/cu. ft. nominal density.
- E. Chilled-water pump insulation shall be the following:
 - 1. Cellular Glass: 3 inches thick.
- F. Chilled-water expansion/compression tank insulation shall be the following:
 - 1. Cellular Glass: 1-1/2 inches thick.
 - 2. Flexible Elastomeric: 1 inch thick.
- G. Heating-hot-water expansion/compression tank insulation shall be the following:
 - 1. Calcium Silicate: 2 inches thick.
- H. Chilled-water air-separator insulation shall be one of the following:
 - 1. Cellular Glass: 2 inches thick.
 - 2. Flexible Elastomeric: 2 inches thick.
- I. Heating-hot-water air-separator insulation shall be one of the following:
 - 1. Calcium Silicate: 3 inches thick.
 - 2. Mineral-Fiber Pipe and Tank: 2 inches thick.
- J. Piping system filter-housing insulation shall be one of the following:
 - 1. Cellular Glass: 3 inches thick.
 - 2. Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density.
 - 3. Mineral-Fiber Pipe and Tank: 2 inches thick.

3.22 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 - 1. Drainage piping located in crawl spaces.
 - 2. Underground piping.
 - 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.23 INDOOR PIPING INSULATION SCHEDULE

- A. Condensate and Equipment Drain Water below 60 Deg F:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 1 inch thick.
- B. Chilled Water and Brine, 40 Deg F and below:
 - 1. NPS 3 and Smaller: Insulation shall be the following:
 - a. Cellular Glass: 2 inches thick.
 - 2. NPS 4 to NPS 12: Insulation shall be one of the following:
 - a. Cellular Glass: 2 inches thick.
 - 3. NPS 14 and Larger: Insulation shall be the following:
 - a. Cellular Glass: 2 inches thick.
- C. Chilled Water and Brine, above 40 Deg F:
 - 1. NPS 12 and Smaller: Insulation shall be the following:
 - a. Cellular Glass: 2 inches thick.
 - 2. NPS 14 and Larger: Insulation shall be the following:
 - a. Cellular Glass: 2 inches thick.
- D. Heating-Hot-Water Supply and Return, 200 Deg F and below:
 - 1. NPS 12 and Smaller: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I: 1 inch thick.
- E. Refrigerant Suction and Hot-Gas Piping:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 1 inch thick.

- F. Hot Service Drains:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Calcium Silicate: 1-1/2 inches thick.
 - b. Mineral-Fiber, Preformed Pipe, Type I or II: 1 inch thick.
- G. Hot Service Vents:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Calcium Silicate: 1-1/2 inches thick.
 - b. Mineral-Fiber, Preformed Pipe, Type I or II: 1 inch thick.

3.24 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Chilled Water and Brine:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Cellular Glass: 3 inches thick.
- B. Heating-Hot-Water Supply and Return, 200 Deg F and below:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.
- C. Refrigerant Suction and Hot-Gas Piping:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 2 inches thick.
- D. Hot Service Drains:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Calcium Silicate: 1-1/2 inches thick.
- E. Hot Service Vents:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Calcium Silicate: 1-1/2 inches thick.

3.25 PREFABRICATED UNDERGROUND PIPING

A. General: Provide factory pre-insulated underground piping for the underground distribution system. The carrier piping shall be of the following material and connections:

Material:

- Schedule 40 Black Steel chilled water
- Connection Type: Welded

Project No. 121505 HVAC Insulation Section 23 0700 - 36

- B. Chilled water piping shall be provided with a factory-installed insulation layer of nominal 3 inch thick polyurethane foam insulation complying with the insulating requirements of ASHRAE Standard 90.1, and protected by an outer jacket of high density polyethylene (HDPE) material. All insulation and thicknesses shall comply with the insulating requirements of ASHRAE Standard 90.1-2007.
- C. The insulation jacket joints shall be joined by watertight couplings, and seals shall completely encapsulate the insulation at each end. Fittings shall also be factory pre-insulated and shall comply with the requirements listed above for straight pipe lengths. The piping shall be designed to withstand 150 psig working pressure at 250 degrees F.
- D. Manufacturers:
 - Rovanco Piping Systems
 - Thermal Pipe Systems, Inc.
 - Perma-Pipe/Ricwil Piping Systems (steam/condensate MT 500, chilled Double Therm)
 - Thermacor

3.26 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
 - 1. Aluminum, Smooth: 0.020 inch thick.
- D. Piping, Exposed:
 - 1. Aluminum, Smooth: 0.016 inch thick.

END OF SECTION 23 0700

SECTION 23 0800 COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
- B. General: The Owner will select a commissioning agency (herein referred to as the CxA) and pay for the services of the commissioning Agency for system and equipment performance verification.
- C. Definition of Terms:
 - a. "Contractor" shall refer to the General Contractor

1.2 SUMMARY

A. Section includes commissioning process requirements for HVAC&R systems, assemblies, and equipment.

1.3 ALLOWANCES

A. Labor, instrumentation, tools, and equipment costs for technicians for the performance of commissioning testing are covered by the "Schedule of Allowances" Article in Division 01 Section "Allowances."

1.4 CONTRACTOR'S RESPONSIBILITIES

- A. Perform commissioning tests at the direction of the CxA.
- B. Attend construction phase controls coordination meeting.
- C. Attend testing, adjusting, and balancing review and coordination meeting.
- D. Participate in HVAC&R systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.
- E. Provide information requested by the CxA for final commissioning documentation.
- F. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.5 CxA'S RESPONSIBILITIES

- A. Provide Project-specific construction checklists and commissioning process test procedures for actual HVAC&R systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.
- B. Direct commissioning testing.

- C. Verify testing, adjusting, and balancing of Work are complete.
- D. Provide test data, inspection reports, and certificates in Systems Manual.

1.6 COMMISSIONING DOCUMENTATION

- A. Provide the following information to the CxA for inclusion in the commissioning plan:
 - 1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
 - 2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
 - 3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for HVAC&R systems, assemblies, equipment, and components to be verified and tested.
 - 4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
 - 5. Certificate of readiness certifying that HVAC&R systems, subsystems, equipment, and associated controls are ready for testing.
 - 6. Test and inspection reports and certificates.
 - 7. Corrective action documents.
 - 8. Verification of testing, adjusting, and balancing reports.

1.7 SUBMITTALS

- A. Certificates of readiness.
- B. Certificates of completion of installation, prestart, and startup activities.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TESTING PREPARATION

- A. Certify that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
- C. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.

- D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- E. Inspect and verify the position of each device and interlock identified on checklists.
- F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.2 TESTING AND BALANCING VERIFICATION

- A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.
- B. Notify the CxA at least 10 days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.
- C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC&R systems at the direction of the CxA.
 - 1. The CxA will notify testing and balancing Contractor 10 days in advance of the date of field verification. Notice will not include data points to be verified.
 - 2. The testing and balancing SubContractor shall use the same instruments (by model and serial number) that were used when original data were collected.
 - 3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.
 - 4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.3 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- B. Scope of HVAC&R testing shall include entire HVAC&R installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.
- C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

- D. The CxA along with the HVAC&R Subcontractor, testing and balancing Subcontractor, and HVAC&R Instrumentation and Control Subcontractor shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.
- E. Tests will be performed using design conditions whenever possible.
- F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- G. The CxA may direct that set points be altered when simulating conditions is not practical.
- H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- I. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.4 HVAC&R SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

- A. Boiler Testing and Acceptance Procedures: Testing requirements are specified in Division 23 boiler Sections. Provide submittals, test data, inspector record, and boiler certification to the CxA.
- B. HVAC&R Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls." Assist the CxA with preparation of testing plans.
- C. Pipe system cleaning, flushing, hydrostatic tests and chemical treatment requirements are specified in Division 23 piping Sections. HVAC&R Subcontractor shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Plan shall include the following:
 - Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.
 - 2. Description of equipment for flushing operations.
 - 3. Minimum flushing water velocity.
 - 4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.

- D. Energy Supply System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of gas and hot-water systems and equipment at the direction of the CxA. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.
- E. Refrigeration System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of chillers, cooling towers, refrigerant compressors and condensers, heat pumps, and other refrigeration systems. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.
- F. HVAC&R Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of air, steam, and hydronic distribution systems; special exhaust; and other distribution systems, including HVAC&R terminal equipment and unitary equipment.
- G. Vibration and Sound Tests: Provide technicians, instrumentation, tools, and equipment to test performance of vibration isolation and seismic controls.

END OF SECTION 23 0800

TERMINAL UNITS (CAV w/ hot water reheat, single duct) DATA COMMON FOR ALL UNITS

1. <u>Pa</u>	Participants rty Participation
Pa Da Da	rty filling out this form and witnessing testing tes of tests tes of tests
2. a.	Test Prerequisites (fill out once, to cover all TU's) The following have been started up and startup reports and prefunctional checklists submitted and approved: All terminal units, except
	All air handlers serving terminal units, except
b.	Hot water pumps All control system functions for this and all interlocking systems are programmed and operable per contract documents, including final setpoints and schedules and with debugging, loop tuning and sensor and device calibrations completed.
c. d.	 Piping system flushing complete, water treatment system complete and required report approved. Airside test and balance calibration of BAS readings of TU flows complete (system total flow need)
e. f. g. h. j. k.	 not be complete). All A/E punchlist items for this equipment corrected. These functional test procedures reviewed and approved by installing contractor. Test requirements and sequences of operation attached. Schedules and setpoints attached. Have all energy savings control strategies, setpoints and schedules been incorporated that this TU and control system are capable of? If not, list recommendations below. The controller & actuator runtime accumulator set to 0 after prefunctional checkout of the entire system. Obtain and review the full program of 5% (randomly chosen) of all TU's of each type (parameters & setpoints, etc.). Examine variances. Clarify as needed, reconcile and document differences with controls contractor. If too many corrections exist with this sample, controls contractor shall recheck all programming.
3.	Sampling and Additional Testing.

A random sample of 10% of all TU's of each type to be tested. The specifications also require that if any of the sampled TU's fail in the testing (any No Pass items), then additional TUs (amount equal to the number that fail) must be tested. This applies to the subsections of the test, i.e., if sub-sections fail, only subsections of additional TU's need to be tested. Record results in the table below.

Sub-Section	% Failed of 1st Sample	% Failed of 2nd Sam- ple	Sub-Section	% Failed of 1st Sample	% Failed of 2nd Sam- ple
I. Sensor calibration			IV. Programming		
		•			

II. Actuator calibration	
III. Static inspections	

V. Functional tests	

4. Testing of TU Control Valves

All TU control heating valves shall be verified to have been programmed and setup properly. When programmed or wired backwards, the valve will open when being commanded to close, causing the space to overheat. To verify proper wiring and programming, during a period of general cooling, verify that the actual space temperature is within 2F of the (setpoint plus any user adjustment), unless in a fluctuating area (entry, etc.). Space temperatures more than 2F above the net setpoint indicate possible control valve problems. Investigate.

TU Space Temperature Control for TU's With Control Valves

TU ID	Actual Space Temp.	Setpoint	User Ad- just-ment	OK?	TU ID	Actual Space Temp.	Setpoint	User Ad- just-ment	OK?

סועד	Actual Space	Setpoint	User Ad-	OK2]		Actual Space	Setpoint	User Ad-	OK3
1010	Temp.	Cerpoint	Just mont	OIT.		1010	Temp.	Cetpoint	Just mont	OIX:
					_					
					1					
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					1					
					1					Ī

TU ID	Actual Space Temp.	Setpoint	User Ad- just-ment	OK?		TU ID	Actual Space Temp.	Setpoint	User Ad- just-ment	OK?
					-					
					-					
					-					
					-					
					-					
					_					
					_					
					_					
					_					

CV__-_-

Common values for all terminal units are recorded on the Cover Sheet. The following four pages of procedures are to be filled out for each TU tested.

Seasonal Testing and General Conditions of Test

Air handler or rooftop unit and boiler (if applicable) should be running in normal and occupied mode, unless noted. The tests may be performed in any season, if any temperature lockouts can be overridden.

Testing Procedures and Record

Computer printout or list made and attached of the current TU setpoints and control parameters and schedules, lockouts, etc. of other systems that may be changed to accomodate testing.

I. Sensor Calibration Checks. Check the sensors listed below for calibration and adequate location. "In calibration" means making a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage or building automation system (BAS)) compared to the test instrument-measured value is within the tolerances specified in the prefunctional checklist requirements. If not, install offset in BAS, calibrate or replace sensor. Use the same test instruments as used for the original calibration, if possible.

Sensor & Loca- tion	Location OK ¹	1st Gage or BAS Value	Instrument Measured Value	Final Gage or BAS Val- ue	Pass Y/N?
Space temp.					

¹ Sensor location is appropriate and away from causes of erratic operation.

II. Device Calibration Checks. Check the actuators or devices listed below for calibration. "In calibration" means observing a readout in the BAS and going to the actuator or controlled device and verifying that the BAS reading is correct. For items out of calibration or adjustment, fix now <u>if easy</u>, via an offset in the BAS, or a mechanical fix.

HCV: Set pumps to normal mode. <u>Procedure 1.</u> Command valve to a few intermediate positions. Verify that reading in BAS reasonably correspond to the actual positions. <u>For heating coil valves (NO):</u> <u>Proce-</u> <u>dure 2a.</u> Set heating setpoint 20°F above room temperature. Verify BAS reading says 100% open. Visually verify valve is fully open. 2b. Remove control air or electricity from the valve and verify that the valve stem and actuator position do not change. <u>Procedure 3.</u> Restore to normal. Set heating setpoint to 20°F below room temperature. Observe the valve close. 4. For pneumatic actuators, by override in the EMS, increase pressure to valve by 3 psi (do not exceed actuator rating). Verify valve stem & actuator position does not change. Restore to normal.

Device or Actuator & Lo-Site Pass BAS Valcation Procedure / State Observation Corrections Y/N ue Heating coil valve (HCV) 1. Intermediate positions position or command and 2a. Full open 2b. Remove power or air (full stroke open) 3. Closed 4. Increase pressure (close)

Damper or Flow: -- Checked during Functional Testing Section.

Project No. 121505

Proced. No. & Spec. Seq. ID ¹	Test Procedure ³ (including special conditions)	Expected and Actual Response ⁴ [Write ACTUAL response or finding in brackets or circle]	Pass Y/N & Note #
1.	Verify sufficient clearance around equipment	for servicing.	
2.	Unit secured per spec.		
3.	Model and tag checked against plans & equip	oment list. TU & valve tags affixed.	
4.	Verify that inlet conditions are OK: Smooth, r diameters when possible and 2 diameters mir and 3 to 5 diameters for single point electronic	ound, straight duct for at least 3 duct nimum for velocity pressure sensor c sensors, else airflow straighteners.	
5.	(Verify for only 1/2 of the tested TU's) For autoflow control valves, with water sys- tem in normal, check pressure drop across valve. Compare with valve requirements.	Pressure drop should be in the range of to psi []. If out of range, in- vestigate.	
6.	(Verify for the other 1/2 of the tested TU's that didn't have valve pressure drops checked.) Valve off TU. Remove and check strainer for cleanliness	To pass, <u>basket</u> strainers must have an unclogged area \geq 80% of the strainer area. <u>In-line</u> strainers with area = to pipe cross section must be 90% clean.	
7.	Auto TU Diagnostics. In the control system diagnostics, check the controller and actua- tor accumulated run times, the moving avg. flow error and moving avg. space temp. de- viation from setpoint.	The ratio of actuator to controller runtime should be ideally < 3% & < 5% is acceptable. [%]. Mov- ing avg. flow error should be < 10% of max. cooling cfm [%]. The moving avg. space temp. de- viation should be < 3F [F].	
9.	Control drawing sequences of operation	Per spec and detail adequate.	
10.	Verify that the TU address matches the TU location and ID on the plan drawings and control drawings.	Address matches.	
11.	Verify that the TU Air Flow setpoints in the BAS match (within 10%) the latest plan drawings and balance report (TAB).	<u>Air Flow:</u> Drawing = BAS max = TAB max =	
12.	Verify that BAS TU K factor is within 20% of K on the submitted control drawings, unless explained by TAB.	Drawing K = BAS K = [] TAB K =	
13.	Temperature adjustment range by tenants (indicate if a setting was spec'd)	Spec'd or reasonable value Found []	
14.	Cooling occupied zone temp. setpoint (indicate if a setting was spec'd)	Spec'd or reasonable value Found []	
15.	Heating occupied zone temp. setpoint (indicate if a setting was spec'd)	Spec'd or reasonable value Found []	
16.	Heating coil valve stroke time (for incremen- tal valves)	Actual timed Input found in BAS	
17.	Cooling space setpoint proportional band (indicate if a setting was spec'd)	Spec'd or reasonable value Found []	

Proced. No. & Spec. Seq. ID ¹	Test Procedure ³ (including special conditions)	Expected and Actual Response ⁴ [Write ACTUAL response or finding in brackets or circle]	Pass Y/N & Note #
18.	Heating space setpoint proportional band (indicate if a setting was spec'd)	Spec'd or reasonable value Found []	
19.	Damper stroke time (Spec'd value comes from controller spec, unless oval duct, which should then be timed)	Spec'd Found []	
20.	Auto-zero function schedule set and ena- bled.	Set and enabled.	
27.	(Verify for only 1/2 of the tested TU's) <u>Warmup cycleheating.</u> Adjust schedule or time so TU will be in warmup mode. Adjust the space setpoint to be 5F above space.	Does HCV go to full open?	
28.	(Verify for only 1/2 of the tested TU's) <u>Warmup cyclecooling.</u> Adjust schedule or time so TU will be in warmup mode. Adjust the space setpoint to be 5F below space.	Does HCV go to full closed?	
29.	<u>HCV leakage.</u> With the TU in cooling, with the damper in a stable position, using matched sensors, measure the duct air temperature within 4 ft. upstream and down- stream of the coil.	Upstream:F Down:F The temperature down stream should not be warmer than the air up stream. If more than 1.0F greater, unit fails. Investigate.	
30.	Trending: HCV and Damper Control. Over an 26 hour occupied and unoccupied period, trend at 2 min. intervals, the HCV position, the HCV command, the damper position or cfm, the space temperature, OSAT and the duct static pressure at the controlling sensor. The trend period shall have both heating and cooling conditions. Simulate if necessary.	Compare actuals to cfm and space temp. setpoints. Compare to the schedule. Observe that there is little or no overshoot of space tem- perature or hunting of the valve, that cfm is within its deadband and that the valve changes from heat- ing to cooling as the space temp goes outside deadbands.	
31.	<i>(Trend for only 1/2 of the tested TU's)</i> <u>Trending.</u> Over a 3 day period, during near design conditions for heating and cooling, trend space temp. at 10 minute intervals. Omit this test if auto diagnostics has a mov- ing avg. space temp. deviation log and it was completed.	Observe that the space temp. does not drift more than 1°F outside the deadband range around the set- point.	
32.	Return all changed control parameters and conditions to their pre-test values ⁵	Check off in program printout when completed	

MONITORING AND TREND LOGGING

Monitoring via BAS trend logs are required for test procedures 36; 37. Attach representative graphs or columnar data and explanatory analysis to this test report. The data should have time down the left column and four to six columns of parameters to the right. Provide a key to all abbreviations and attach setpoints and schedules for all trended parameters. **<u>Abbreviations:</u> BAS = building automation system, CA = commissioning agent, HCV = heating coil valve, TU = terminal unit, SA = supply air, plan drawing = building drawings and schedules from design engineer.

¹Sequences of operation attached to this test.

²Mode or function ID being tested from testing requirements section of the project Specifications.
³Step-by-step procedures for manual testing, trend logging or data-logger monitoring.
⁴Include tolerances for a passing condition. Fill-in spaces or lines not in brackets denote sequence parameters still to be specified by the A/E, conrols contractor or vendor. Write "Via BAS" for verifications of device position from BAS readout or "Via obs" for actual observation or from test instrument reading.

⁵Record any permanently changed parameter values and submit changes to Owner. A SUMMARY OF DEFICIENCIES IDENTIFIED DURING TESTING IS ATTACHED

-- END OF TEST --

COOLING AIR HANDLING UNIT

AHU- _____

1. Participants Party		<u>F</u>	Parti	icipation		
Party filling out this form	a & witnessing			Date of	Test	
 Prerequisite Check a. The following have be proved ready for function Chilled Water S Connected Terr Cooling towers MI control system contract documents, calibrations complete 	cklist een started up nal testing: system minal Units functions for including final ed.	and startup r this and all int set points an	epo (() terlo	orts and prefunctional ch Condenser water pumps Chilled water piping and Variable speed drives fo ocking systems are prog chedules with debugging	ecklists subm valves r pumps rammed and g, loop tuning	nitted and ap- operable per and sensor
Controls Corr c Piping system flux d Water treatment s e Vibration control r f Test and balance nected. g All A/E punchlist i h These functional	ntractor Signat shing complete system complete report approve (TAB) comple tems for this e test procedure	ure or Verbal e and required te and operat d (if required) ted and appro quipment cor s reviewed ar	d re tion ove rect	Date ports approved. al. d for the hydronic syster ed. approved by installing co	ns and termin	nal units con-
i Safeties and oper	ating ranges r	eviewed.	<u>n</u> 2	ittached		
k. Schedules and se	et points attach	es of operation ned.	50.9			
I False loading equ	ipment, syste	m and proced	lure	s ready (boilers, prehea	at or reheat c	oils, control
loops, over-ride on m Have all energy s	OSA dampers	, etc.) strategies se	ot n	oints and schedules bee	n incorporate	d that this
equipment and cont	trol system are	capable of?	lf r	not, list recommendation	s below.	
n. <u>Control Program</u> ters, set points and	n Review. Re logic sequenc	eview the soft es appear to f	war follo	e control program(s) for ow the specified written s	this equipme sequences.	ent. Parame-
Schedules, Etc. Cha	nged to Accon	nmodate Test	ing:		Tills, Delays,	LUCKUUIS,
ParameterPre-Test ValuesReturned to Pre- Test Val- ues $$ ParameterPre-Test ValuesReturned to Pre- Test Val- ues $$						
Supply air temp.		· ·		Dirty filter D.P.		
Return Air temp.				CHWS temp.		
Mixed Air temp.				CHWR temp.		

Zone Discharge air

temp.

TLC Engineering Solutions

Space temp.

OA damper	
Supply fan status	
Supply fan run time	

Space humidity	
CHW Coil control	
valve	
Supply fan schedul-	
ing	

3. Sensor Calibration Checks. Check the sensors listed below for calibration and adequate location. This is a sampling check of calibrations done during prefunctional checklisting.

"In calibration" means making a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage or building automation system (BAS)) compared to the test instrument-measured value is within the tolerances specified in the prefunctional checklist requirements (______). If not, install offset in BAS, calibrate or replace sensor. Use the same test instruments as used for the original calibration, if possible.

Sensor & Location	Loc- ation OK ¹	1st Gage or BAS Value	Instr. Meas'd Value	Final Gage or BAS Value	Pass Y/N?	Sensor & Location	Loc- ation OK ¹	1st Gage or BAS Value	Instr. Meas'd Value	Final Gage or BAS Value	Pass Y/N?
SAT						Zone SAT					
RAT						Zone RH					
MAT											

¹Sensor location is appropriate and away from causes of erratic operation.

4. Device Calibration Checks. The actuators or devices listed below checked for calibration. This is a spot check on a sample of the calibrations done during prefunctional checklisting and startup.

"In calibration" means observing a readout in the BAS and going to the actuator or controlled device and verifying that the BAS reading is correct. For items out of calibration or adjustment, fix now if easy, via an offset in the BAS, or a mechanical fix.

Device or Actuator & Location	Procedure / State	1st BAS Value	Site Observation	Final BAS Reading	Pass Y/N
Cooling coil valve (CCV)	1. Intermediate positions				
Position or command and	2. Full open				
stroke*	3. Increase pressure (open)				
	4. Closed				
	5. Remove power or air (cl.)				
OSA damper position**	1. Closed				
	2. Full open				

* Set pumps to normal mode. <u>Procedure 1.</u> Command valve to a few intermediate positions. Verify that readings in BAS reasonably correspond to the actual positions. <u>For cooling coil valves (NC):</u> <u>Procedure 2.</u> Lower set point to 20F below previous temperature. Verify BAS reading says CCV is 100% open. Visually verify valve is 100% open. *Procedure 3.* For pneumatic actuators, by override in the EMS, increase pressure to valve by 3 psi (do not exceed actuator rating). Verify valve stem & actuator position does not change. Restore to normal. *Procedure 4.* Raise set point to 20F above previous temperature. Verify BAS reading says CCV is closed. Visually verify valve is closed. *Procedure 5.* Remove control air or electricity from the valve and verify that the valve stem and actuator position do not change. **1. Command damper closed and verify that damper is shut and BAS reads shut. 2. Do the same, commanding damper fully open.

5. Verification of Misc. Prefunctional Checks.

Misc. site checks of the prefunctional checklist and startup reports completed successfully. Pass? Y / N _____

General Conditions of Test

6. Functional Testing Record

Seq. ID	Mode ID ²	Test Procedure³ (including special conditions)	Expected Response ⁴	Pas s Y/N	Note
1	FAN OFF	Standby Check. With Units Commanded off by BAS.	Verify by visual inspection that: Outside Air Damper in AHU is Closed Cooling Coil Valve on Cooling Coil of AHU is Closed		
2	UNIT STARTUP	With Units Commanded on by BAS	AHU Fans Start OA Damper Opens Exhaust Fans start.		

Seq. ID	Mode ID ²	Test Procedure³ (including special conditions)	Expected Response ⁴	Pas s Y/N	Note
3	SUPPLY AIR TEMPERATUR E SET POINT	Adjust supply air temperature set point up 5 degrees F and trend supply air temperature for 30 minutes. Trend control valve out- put concurrently.	Verify stable control during 30-minute period. Three-way chilled water control valve should modulate to maintain a face air temperature set point.		
4	LOW TEMPERATUR E ALARM	Manually lower discharge temper- ature sensor below set point. Re- peat for each temperature sensor.	BCS should alarm Operator.		
5	SMOKE CONDITIONS	Interfacing with EC, simulate a fire mode with the Fire Alarm System	Verify that AHU System re- turns to FAN OFF Status, with OSA Damper in a Closed Position.		
6	FREEZE CONDITION	Overwrite Low Limit on CHWR sensor reading to be 60 Deg. F.	Verify that system alarms, fans stop, OSA Damper clos- es.		
7	AHU FILTER DROP	Simulate filter loading by partially blocking pre-filter section with cardboard or similar material.	Verify that the BAS reports an alarm when pressure rises above the set point of 0.6 in wg for pre-filters.		
8	REVIEW	Review schedules, current set points and sequences with Speci- fication Section 15950 and Con- trol Drawings prepared by CC	Submit approved differences to be incorporated into as- builts.		

Record Foot Notes

¹Sequences of operation specified in Contract Documents (attached).

²Mode or function ID being tested from testing requirements section of the project Specifications.

³Step-by-step procedures for manual testing, trend logging or data-logger monitoring.

⁴Include tolerances for a passing condition.

⁵Record any permanently changed parameter values and submit to Owner.

-- END OF TEST --

Chiller System Including: CH-1, 2 and 3, PCHWP-1, 2 and 3, CT-1, 2, and 3, and CWP -1, 2 and 3

1. Participants

Party	Participation
Party filling out this form and witnessing testing _ Dates of tests Dates of tests Dates of tests Dates of tests	
2. Test Prerequisites	

- a. ____ The following have been started up and startup reports* and prefunctional checklists submitted and approved ready for functional testing:
 - __ Chiller

<u>Condenser water pumps</u>

Chilled water pumps

- ___ Chilled water piping and valves
- Cooling towers, fans, and VFD's

*The written chiller startup report must contain a full listing of all adjustable internal program settings.

b. ____All control system functions for this and all interlocking systems are programmed and operable per contract documents, including final setpoints and schedules and with debugging, loop tuning and sensor and device calibrations completed.

Date

Controls Contractor Signature or Verbal

- c. ___ Piping system flushing complete and required report approved.
- d. ___ Water treatment system complete and operational.
- e. ____ Test and balance (TAB) complete and approved for the hydronic system.
- f. ____ All A/E punchlist items for this equipment corrected.
- g. ___ These functional test procedures reviewed and approved by installing contractor.
- h. ____Safeties and operating ranges reviewed.
- i. ____Test requirements and sequences of operation attached.
- j. ___ Schedules and setpoints attached.
- k. ____ False loading equipment, system and procedures ready (cross-over piping, preheat or reheat coils, control loops, over-ride on OSA dampers, etc.)
- I. ____ Sufficient clearance around equipment for servicing.
- m. <u>Control Program Review</u>. Review the software control program(s) for this equipment. Parameters, setpoints and logic sequences appear to follow the specified written sequences.
- n. ___ Record made of All Values for Current Setpoints (SPt), Control Parameters, Limits, Delays, Lockouts, Schedules, Etc. Changed to Accommodate Testing:

Parameter	Pre-Test Values	Returned to Pre- Test Val- ues √	Parameter	Pre-Test Values	Returned to Pre- Test Val- ues √	
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Parameter	Pre-Test Values	Returned to Pre- Test Val- ues √	Parameter	Pre-Test Values	Returned to Pre- Test Val- ues √
Space Temp. Setpts			Primary CHW Pumps PCHWP-1 PCHWP-2		
			(hand, off, auto)		
Boiler enable, heat-			Manual piping &		
CHWS SPt temp			Exhaust fans Refrigerant (hand, off, auto)		
Safety Overrides			CT makeup valve CT-1 CT-2 (auto, manual)		
Chillers CH-1: CH-2:			Secondary CHW Pumps SCHWP-1 SCHWP-2		
(hand, off, auto)			(hand, off, auto)		
CH-1: CH-2:			CWP-1 CWP-2		
(normal, jumped)			(hand, off, auto)		
CHW diff. press. Spt Across pump: Out in system:			CT fans CT-1 CT-2 (hand, off, auto)		
Delays			CT vibration sensors CT-1 CT-2 CT-3 (normal, jumped)		

3. Sensor Calibration Checks. The sensors listed below checked for calibration and adequate location. This is a spot check on a sample of the calibrations done during prefunctional check listing.*

"In calibration" means making a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage or building control system (BCS)) compared to the test instrument-measured value is within the tolerances specified in the prefunctional checklist requirements. If not, install offset in BCS, calibrate or replace sensor. Use the same test instruments as used for the original calibration, if possible.

Test instrument, air pressure: last 12 mo's.	Certified calibration within
Test instrument, water pressure: last 12 mo's.	Certified calibration within

Test instrument, temperature: _____ Certified calibration within last 12 mo's.

Sensor & Loca- tion	Location OK ¹	1st Gage or BCS Value	Instr. Meas'd Value	Final Gage or BCS Value	Pass Y/N?
CHWST					
CHWRT					
CWST					
CWRT					

¹Sensor location is appropriate and away from causes of erratic operation.

*For every sensor originally found out of calibration, check one additional sensor not listed.

4. Device Calibration Checks. The actuators or devices listed below checked for calibration. This is a spot check on a sample of the calibrations done during prefunctional checklisting and startup.**

"In calibration" means observing a readout in the BCS and going to the actuator or controlled device and verifying that the BCS reading is correct. For items out of calibration or adjustment, fix now if easy, via an offset in the BCS, or a mechanical fix.

Device or Actuator & Location	1st BCS Read- ing	Site Ob- serv- ation	Final BCS Reading	Pass Y/N
PCHWP-1 rpm				
SCHWP-1 rpm				
CWP-1 rpm				
CH-1 Supply valve				

Device or Actuator & Location	1st BCS Reading	Site Ob- serv- ation	Final BCS Reading	Pas s Y/N
CT-1 speed				
CT-2 speed				
CH-1 Re- turn valve				

**For every actuator or device originally found out of calibration, check one additional one not listed.

5. Verification of Misc. Prefunctional Checks:

Misc. site checks of the prefunctional checklist and startup reports completed successfully. Pass? Y / N _____

6. Notes on Methods Used to False Load Chiller:

7. Seasonal Testing and General Conditions of Test:

Testing of all chillers close to full load and full cooling tower fan staging will be executed in the summer. Summer season will closely match full load conditions, so it is not likely to require some false loading to create close to full load conditions.

8. Test Procedure Table of Contents

1-9
12-21
22-24

Procedure #

9. Testing Procedures and Record

Proced. No. 1	Test Procedure ³ (including special conditions) Startup Sequence. CH-1, base	Expected and Actual Response ⁴ [Write ACTUAL response in brackets or circle] BCS should issue operator alert to oper-	Pass Y/N	Note #
	(This is not the <u>initial</u> startup by factory reps). With chiller system off, with sched- ule allowing chillers ON, turn chill- ers and pumps to manual. Turn on AHUs and cause a call for cooling sufficient to call for chillers (see manually open preheat coil valve, lower space temperature SPt, etc. A call for the chillers will be made when any AHU fan is ON.	Observe CHW primary and secondary pumps turning on, then the oil pump; then the CD pump (30-60s delay ea.) Observe that secondary pumps start at minimum RPM and slowly ramp up. Start- ing RPM = []. Observe that the vanes start closed and begin to open. (max spd = 0-full open in ~3 min. and closed in ~1 minute)		
1 cont.	Condenser Water Operation Once chilled water and condenser water flow is established, the dif- ferential pressure switches shall activate the chiller.	Observe that once chilled water flow is established via the chiller evaporator dif- ferential pressure switch, the respective condenser water control valve shall open and a condenser water pump shall acti- vate. When condenser water flow is established via the pump differential pressure switch, the chiller shall start.		
1 cont.	<u>CH-1 Operation</u> When operating the base chiller, the interconnecting loop shall be enabled. This is accomplished by opening the supply and return valves.	Observe the measurements of new bi- directional turbine flow meter. Control valve to provide constant 860 gpm [] to existing building loop.		
2	Secondary CHWP Staging ON. Continue increasing cooling load, if necessary, to cause operator alert to operate secondary pump.	Observe that the 2 pumps' rpm are ap- prox. equal and at approx., [CHWP- rpm, CHWP rpm] and that total flow is just over previous gpm [gpm], and that after ~ 2 minutes, pump dP is maintained at SPt [] and remote dP is maintained at SPt [].		

Proced. No. 3	Test Procedure ³ (including special conditions) <u>Chillers Staging ON.</u> With chillers in manual, and loaded such that only base chiller is running, raise CHWRT above set-point.	Expected and Actual Response ⁴ [Write ACTUAL response in brackets or circle] BCS issues operator alert to operate one additional chiller and both pumps.	Pass Y/N	Note #
3 cont.	<u>Chillers Staging ON.</u> Running base chiller, activate one additional chiller and both pumps.	Total primary flow = [gpm] Secondary CHW flow => primary CHW flow = [gpm] and base chiller is at least 95% loaded (by % of rated current), [amps]. Time: []. Observe that the amps on both chillers are within 5% of each other.		
4	<u>Chillers Shutdown.</u> Decrease CHWRT to below set- point. Note the adjustable time delay pe- riod for chiller restart.	BCS issues operator alert to shutdown existing chiller with most runtime. Runtime first chiller: []. Runtime second chiller: []. Time delay period:[]. Time shutdown occurred:[].		
5	Verify Chillers Restart Delay. Shutdown chillers and pumps. In- crease the CHWRT to above set- point and immediately attempt to restart base chiller.	BCS issues operator alarm/notification to that time delay period has not expired.		
6	Cooling Tower: Change condenser water tempera- ture setpoint down 5 degrees F. Trend fan rpm, OSAWB, and Con- denser Water Supply Temperature for 4 hours.	Observe that the ECWT SPt of OSA wet bulb + 7F is maintained (within 65F to 85F). Observe that the cooling tower suc- cessively stages up as the setpoint re- mains unsatisfied. Record results. <u>Time Fan RPM OSAWB</u> <u>CWST</u>		

Proced.	Test Procedure ³	Expected and Actual Response ⁴	Pass	
No.	(including special conditions)	[Write ACTUAL response in brackets or	VAL	Note
7		Circlej	T/N	#
1	Trend cooling tower operation for	sively stages up as the setpoint remains		
	24 hours.	unsatisfied. Record results.		
		Time Fan RPM OSAWB		
		<u>CWST</u>		
		Monitor CT fan vibration through vibration		
		sensors. Demonstrate that fan speed		
		control loop is stable and responsive.		
8	1st Lag Cooling Tower Staging	Observe that the cooling tower succes-		
	During the preceding sequence 8	unsatisfied. Record results.		
	on 1 st Lag Cooling Tower.	Time Fan RPM OSAWB		
		<u>CWST</u>		
		Monitor CT for vibration through vibration		
		sensors. Demonstrate that fan speed		
		control loop is stable and responsive.		
9	For all chiller and cooling tower	Setpoints and sequences are the same as		
	components, review current set-	original specs. OR		
	cations and control drawings.	Differences submitted for as-builts.		
	Submit approved differences to be			
10	CHW Flow Switch, CH-1	Observe alarm is generated		
	If PCHW pump is wired in series	Costive alarm is generated.		
	with proof of flow switch, jumper			
	pump out of this loop. With chillers			
	that will call for chillers, manually			
	turn off PCHW pump.			

Proced. No. 11	Test Procedure ³ (including special conditions) <u>CHW Flow Switch CH-2.</u> If PCHW pump is wired in series with proof of flow switch, jumper pump out of this loop. With chillers manually off, but under conditions that will call for chillers, manually turn off PCHW pump.	Expected and Actual Response ⁴ [Write ACTUAL response in brackets or circle] Observe alarm is generated.	Pass Y/N	Note #
12	Low evap. refrigerant temp/pressure TBD CH-1 CH-2	Indicator lights for alarms, cutouts and normal running function properly. Compressor does not restart after cutout.		
13	<u>High condenser pressure</u> TBD CH-1 CH-2	Indicator lights for alarms, cutouts and normal running function properly. Compressor does not restart after cutout.		
14	High motor winding temperature TBD CH-1 CH-2	Indicator lights for alarms, cutouts and normal running function properly. Compressor does not restart after cutout.		
15	Low differential oil pressure TBD CH-1 CH-2	Indicator lights for alarms, cutouts and normal running function properly. Compressor does not restart after cutout.		
16	Low differential oil pressure TBD CH-1 CH-2	Indicator lights for alarms, cutouts and normal running function properly. Compressor does not restart after cutout.		

Proced. No.	Test Procedure ³ (including special conditions)	Expected and Actual Response ⁴ [Write ACTUAL response in brackets or circle]	Pass Y/N	Note #
	TBD CH-1 CH-2	normal running function properly. Compressor does not restart after cutout.		
18	High oil temperature TBD CH-1 CH-2	Indicator lights for alarms, cutouts and normal running function properly. Compressor does not restart after cutout.		
19	High bearing temperature TBD CH-1 CH-2	Indicator lights for alarms, cutouts and normal running function properly. Compressor does not restart after cutout.		
20	Ground fault protection TBD CH-1 CH-2	Indicator lights for alarms, cutouts and normal running function properly. Compressor does not restart after cutout.		
21	Interlocking of chillers and pumps This is demonstrated in procedures above (not the safeties).			
22	CT-1 Fan Failure Alarm. With CT running, manually shut off its fan motor.	Observe that an alarm is registered. Lag CT comes on line Manually		
23	CI-2 Fan Failure Alarm. With CT running, manually shut off its fan motor.	Observe that an alarm is registered. Lag CT comes on line Manually		
24	(if not documented during startup) Jump the vibration sensor to simu- late a vibration alarm. <u>CT-1:</u> <u>CT-2:</u>	Observe that an alarm is registered and that the CT fan shuts off. Lag CT comes on line Manually		
25	Return all changed control pa- rameters and conditions to their pre-test values ⁵	Check off in table of Section 2 above when completed		

MONITORING AND TREND LOGGING

Monitoring via BCS trend logs are required per test procedures. Attach representative graphs or columnar data and explanatory analysis to this test report.

**<u>Abbreviations:</u> SCHW = secondary chilled water, PCHW = primary chilled water. dP = diff. pressure, SPt = setpoint

CHWS = chilled water supply, CT = cooling tower, BCS = building automation sys-

tem.

¹Sequences of operation attached to this test.

²Mode or function ID being tested from testing requirements section of the project Specifications.
 ³Step-by-step procedures for manual testing, trend logging or data-logger monitoring.
 ⁴Include tolerances for a passing condition. Fill-in spaces or lines not in brackets denote sequence parameters still to be specified by the A/E, controls contractor or vendor. Write "Via BCS" for verifications of device position from BCS readout or "Via obs" for actual observation or from test instrument

reading.

⁵Record any permanently changed parameter values and submit changes to Owner.

⁶ Methods to False Load Chillers

1) Lower the space temperature setpoint.

2) Prior to the chiller test, manually preheat the building space temperature to 78F - 80F.

3) Lower the chilled water supply temperature setpoint.

False Loading Cooling Towers

1) False load the chiller (see above)

A SUMMARY OF DEFICIENCIES IDENTIFIED DURING TESTING IS ATTACHED

-- END OF TEST --
Chiller System Including: SHWP-1, 2 and 3, HRP-1 and 2, B-1, 2 and 3

1. Participants

Party	Participation
Party filling out this form and witnessing testing	
Dates of tests	
Dates of tests	
Dates of tests	

2. Overview

In general, the Functional Performance Testing of the Boiler systems will include the following:

- Review all SVCs for boilers, and associated pumps
- Testing of Fuel Systems primary and backup

3. Prerequisite Checklist

- 1) The following have been started up and startup reports and system verification checklists (SVC's) submitted and approved ready for functional testing:
 - a) <u>Boilers</u>
 - b) ____ Heating water piping and valves
 - c) _____ Heating water pumps
 - d) ____ Variable speed drives
- All control system functions for this and all interlocking systems are programmed and operable per contract documents, including final setpoints and schedules and with debugging, loop tuning and sensor and device calibrations completed.

Controls Contractor Signature or Verbal Date

- 3) ____ Piping system flushing complete and required report approved.
- 4) ____ Water treatment system complete and operational.
- 5) _____ Test and balance (TAB) complete and approved for the hydronic system.
- 6) ____ These functional test procedures reviewed and approved by installing contractor.
- 7) ____ Safeties and operating ranges reviewed.
- 8) ____ Sufficient clearance around equipment for servicing.
- 9) **Packaged Control Program Review.** Review the packaged control program(s) for this equipment. Parameters, setpoints and logic sequences appear to follow the specified written sequences.
- 10) ___ Record made of All Values for Current Setpoints (SPt), Control Parameters, Limits, Delays, Lockouts, Schedules, Etc. Changed to Accomodate Testing:

Parameter	Pre-Test Val- ues	Returned to Pre-Test Values √
Space Temp. Setpts		
Boiler enable OSAT setpoint		
Capacity (%) on lead boiler when lag boiler will start		
Time delay between stages		
Setpoint range for boilers		
Differential pressure setpoint		
Supply temp. reset schedule:	<u>OSAT/ HWST</u>	

General Conditions of Test and Seasonal Testing

The primary testing will occur during typical summer weather with minimal heating loads. Because the boiler will be operated year-round, the trends described in the testing procedures will be repeated during colder weather to ensure that the boilers are functioning properly in peak heating season.

False Loading. Be prepared to raise the space temperature setpoints to cause a real load on the heating system.

Trending During Testing. Prior to beginning testing, set up the following trends:

- 1) Secondary Pumping, Trend at 5 minute intervals during testing:
 - a) ____SHWP-1 speed
 - b) ____SHWP-2 speed
 - c) ____HW-Differential Pressure setpoint
 - d) ____HW-Differential Pressure
 - e) _____Avg Heating coil valve positions for terminal units
 - f) ____Heating water flow (HW-F).
- 2) <u>Hot Water Supply Temperature (HWS-T) Control.</u> Trend the HWS-T and OSAT at 5 minute intervals during the testing to verify constancy of HWS-T.

4. Testing Procedures and Record

Test Step	Test Suc- cess (Y/N)	Remarks

Test Step	Test Suc-	Remarks
	cess (Y/N)	
 Staging Up During OSAT < 65F, manually shut OFF boilers and keep pumps running on man- ual to lower boiler water temperature to < 120F. With the boilers OEE, and boiler water 	h	b. Boilors and all pumps should romain
 b. With the boliefs OFF, and bolief water temperature < 120F, overwrite the OSAT to be 66F and turn all systems to auto. c. Overwrite the OSAT to be 64F. 	D	OFF.
	C	c. A secondary pump should start. After [] minutes delay, combustion supply fan, lead hot water pump and boiler start.
2) Observe the HWS-T command to the boilers. Release the overwritten OSAT to be actual.		The command should be between 120F and 180F.
 Increase building load, as necessary, using methods below (list). Lower the delay time between all stages to 3 minutes. Observe the staging of the boilers. 		When the lead boiler reaches [%] (68%), the lag boiler starts. (HWS-T) is [F] & the return (HWR- T) is [F].
 4) Continue observing during staging. In- crease load to require lead and lag boilers to stage on until all boilers are firing. 		Lead and lag boilers fire together, shar- ing load. (HWS-T) is [F] & the return (HWR- T) is [F].
5) Staging Down. Remove all false loading to cause no call for heating.		Lag boilers stage off in reverse se-
 6) Continue dropping the load or overwrite the HWS-T to be just high enough for the loop to be satisfied and no need for boil- ers. 		When the HWS-T setpoint drops to 120F [F] for 3 minutes [], the lead boiler and primary pump drop OFF []
7) Return the systems to normal, keeping the delay time at 3 minutes. Let boilers start. Overwrite the OSAT to be 67F and the HWS-T to be 5F greater than the cur- rent setpoint ofF.		After minutes [], all boilers shut OFF.
8) HWST Reset. Overwrite the OSAT to be 15F, 25F, 40F; 65F. For each, record the HWS-T setpoint command.		All values should fall within 2F of the re- set line.
9) Trend Log. Trend (not during testing) the OSAT, the HWS-T, HWS-T setpoint and the HWS-T minus HWS-T setpoint (the variance from setpoint), at 15 minute in- tervals from Thursday noon to Saturday noon.		All the (HWS-T minus HWS-T setpoint) values should be + or - 2F. Largest undershoot: [F]. Largest overshoot [F]. Number of values out of desired range (+/-2F): [data points] out of [] total points = [%] outside specified range.

Test Step	Test Suc- cess (Y/N)	Remarks
10) Loop DP Control via Trending. Observe the Secondary Pumping trend logs per- formed during testing, specified in the General Conditions of Test section above		The running secondary pump ramps up in speed to maintain the loop DP setpoint farthest from setpoint. Observe that overshoot or undershoot of the loop differential pressure (DP) is with- in +/- 10% of the setpoint magnitude. Greatest undershoot: [psi =%]. Greatest overshoot: [psi =%]. Number of values out of desired range (+/-10%): [data points] out of [] total points = [%] outside specified range.
11) Variable Speed Drive (VFD) on Second- ary hot water pump SHWP-1.		Motor manufacturer's recommended speed low limit = [% of max.].
 a. Carefully go over prefunctional check- list and programming record and iden- tify anomalies. Record the low limits. 	a	 a. Low limit setting in drive: [Hz, rpm =% of maximum]. Provide reasons for low limit not being at motor mfr's low limit.
		Also review any BAS software low limit- ing parameters. Verify that they are not unnecessarily preventing pumps to mod- ulate down to their safe minimum.
 b. With only one boiler running and other boilers manually OFF, reduce all heat- ing load or manually lower pump and remote differential pressure setpoints. See how low VFD will go. (This could be done during the Staging Down pro- cedures above.) 	b	 b. Lowest speed drive will go: [Hz, rpm]. Is this within 3 Hz of the low limit setting (or within a range equal to 5% of maxi- mum speed)? Is pump and remote dP SP maintained without hunting?
 c. Call for moderate heating or increase differential pressure setpoints. 	C	 c. Does VFD motor ramp up accordingly in a reasonable time? Is pump and remote dP SPt maintained without hunting? (This is verified in Proceeding 20)
differential pressure setpoints (keep- ing only 1 boiler ON).		d. Does VFD motor ramp to full speed in a reasonable time?
e. Switch VFD into bypass operation, if feature available.	d	Is pump and remote dP SPt maintained without hunting? (This is verified in Pro- cedure 20.)
	e	e. Verify that pump works in bypass mode.
12) Repeat Test 11 with each secondary pump.		

Test Step	Test Suc- cess (Y/N)	Remarks
 13) Staging Up of Secondary Pumps (via Trending.) Observe the Secondary Pumping trend logs performed during testing, specified in the General Conditions of Test section above. 		From the trends, with only one secondary pump ON, when the flow at HW-F ex- ceeds the rated gpm, of one pump [gpm;rpm or Hz], forminutes [], the first lag pump starts and both equalize in rpm or Hz [,].
 14) Staging Down of Secondary Pumps (via Trending.) Observe the Secondary Pumping trend logs performed during testing, specified in the General Conditions of Test section above. 		With two secondary pumps ON, when the flow at HW-F is less than the rated gpm of both ON pumps, [] gpm; rpm or Hz], bygpm [], forminutes [], the last lag pump stops.
15) With each boiler at a time acting as lead ON, manually shut it OFF.	B-1 B-2 B-3	Lag boiler shall start and an alarm is generated in the BAS.
16) With each boiler at a time acting as lead ON, manually shut its pump OFF.	B-1 B-2 B-3	Lag boiler and pump shall start and an alarm is generated in the BAS.
17) With boilers in auto., shut OFF one of the ON secondary HW pumps.		The lag secondary pump is started and an alarm is generated in the BAS.
18) High limit. For each boiler when ON, low- er the high limit setting to the current wa- ter temperature to initiate an alarm and	B-1 B-2	Boiler burners shut OFF and an alarm is generated in the BAS
shutdown. Manually reset.	B-3	
19) Fuel system safety. For each boiler, when ON, jump or remove wires or close gas valve, as appropriate, to simulate an unsafe gas condition.	B-1 B-2 B-3	Boiler shuts OFF and an alarm is gener- ated in BAS.
20) Flame safety controls. For each boiler, when ON, demonstrate the function of the flame safety controls by simulating an alarm condition.	B-1 B-2 B-3	Boiler shuts OFF and an alarm is gener- ated in BAS.

Test Step	Test Suc- cess (Y/N)	Remarks
21) Lift lever of each pressure relief valve.	B-1	Each releases water.
	B-2	
	B-3	
22) Return all changed control parameters and conditions to their pre-test values		

MONITORING AND TREND LOGGING. Monitoring via BAS trend logs are required per General Test Conditions and test Procedures. Attach representative graphs or columnar data and explanatory analysis to this test report. Columnar and electronic data shall have time in the left column and 4 to 6 columns of different parameters to the right. All abbreviations shall have definitions provided and all setpoints and schedules for each parameter shall be attached.

**<u>Abbreviations:</u> HWS-T = hot water supply temperature to the building, SPt = setpoint, BAS = building automation system.

A summary of deficiencies identified during testing is attached

-- END OF TEST --

SECTION 23 0900 INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

1.3 DEFINITIONS

- A. DDC: Direct digital control.
- B. I/O: Input/output.
- C. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.
- D. MS/TP: Master slave/token passing.
- E. TCP/IP: Transmission Control Protocol/Internet Protocol
- F. PC: Personal computer.
- G. RTD: Resistance temperature detector.

1.4 SYSTEM PERFORMANCE

- A. Comply with the following performance requirements:
 - 1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
 - 2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
 - 3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
 - 4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
 - 5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
 - 6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.

- 7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
- 8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
 - a. Water Temperature: Plus or minus 1 deg F.
 - b. Water Flow: Plus or minus 5 percent of full scale.
 - c. Water Pressure: Plus or minus 2 percent of full scale.
 - d. Space Temperature: Plus or minus 1 deg F.
 - e. Ducted Air Temperature: Plus or minus 1 deg F.
 - f. Outside Air Temperature: Plus or minus 2 deg F.
 - g. Dew Point Temperature: Plus or minus 3 deg F.
 - h. Temperature Differential: Plus or minus 0.25 deg F.
 - i. Relative Humidity: Plus or minus 5 percent.
 - j. Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
 - k. Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
 - I. Airflow (Terminal): Plus or minus 10 percent of full scale.
 - m. Air Pressure (Space): Plus or minus 0.01-inch wg.
 - n. Air Pressure (Ducts): Plus or minus 0.1-inch wg.
 - o. Carbon Monoxide: Plus or minus 5 percent of reading.
 - p. Carbon Dioxide: Plus or minus 50 ppm.
 - q. Electrical: Plus or minus 5 percent of reading.

1.5 SUBMITTALS

A. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with ASHRAE 135 for DDC system components.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.
- B. System Software: Update to latest version of software at Project completion.

1.8 COORDINATION

A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

- B. Coordinate equipment with Division 28 Section "Intrusion Detection" to achieve compatibility with equipment that interfaces with that system and with building master clock.
- C. Coordinate equipment with Division 28 Section "Access Control" to achieve compatibility with equipment that interfaces with that system.
- D. Coordinate equipment with Division 27 Section "Clock Systems" to achieve compatibility with equipment that interfaces with that system.
- E. Coordinate equipment with Division 26 Section "Network Lighting Controls" to achieve compatibility with equipment that interfaces with that system.
- F. Coordinate equipment with Division 28 Section "Fire Detection and Alarm" to achieve compatibility with equipment that interfaces with that system.
- G. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.
- H. Coordinate equipment with Division 26 Section "Electrical Power Monitoring and Control" to achieve compatibility of communication interfaces.
- I. Coordinate equipment with Division 26 Section "Panelboards" to achieve compatibility with starter coils and annunciation devices.
- J. Coordinate equipment with Division 26 Section "Motor-Control Centers" to achieve compatibility with motor starters and annunciation devices.
- K. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 CONTROL SYSTEM

- A. Manufacturers:
 - 1. TRANE, Basis of Design
 - 2. Johnson Controls, Shall comply to Owners Specificifications
- B. BACnet protocol as the common communication protocol between all lower level (custom application and application specific) controllers and ANSI / ASHRAE ™ Standard 135-1995, BACnet between higher level system components (operator workstation and building controllers)to assure interoperability between all system components. BACnet protocol allow the

project to be fully supported by HVAC open protocols to reduce future building maintenance, upgrade and expansion costs.

C. Control system shall consist of building controllers, operator workstation sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on tokenpassing network and programmed to control mechanical systems. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.

2.3 DDC EQUIPMENT

- A. Direct Digital Control (DDC) Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and Uninterruptible Power Source (UPS) backup power source rated for ten minutes of full operation.
 - 1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.
 - 2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
 - a. Global communications.
 - b. Discrete/digital, analog, and pulse I/O.
 - c. Monitoring, controlling, or addressing data points.
 - d. Software applications, scheduling, and alarm processing.
 - e. Testing and developing control algorithms without disrupting field hardware and controlled environment.
 - 3. Standard Application Programs:
 - a. Electric Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, on-off control with differential sequencing, staggered start, antishort cycling, PID control, DDC with fine tuning, and trend logging.
 - b. HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy switchover.
 - c. Chiller Control Programs: Control function of condenser-water reset, chilled-water reset, and equipment sequencing.
 - d. Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.
 - e. Remote communications.
 - f. Maintenance management.
 - g. Units of Measure: Inch-pound and SI (metric).

- 4. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
- 5. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 802-3 (Ethernet) datalink/physical layer protocol.
- B. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.
 - 1. Binary Inputs: Allow monitoring of on-off signals without external power.
 - 2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
 - 3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
 - 4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.
 - 5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA) with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer.
 - 6. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
 - 7. Universal I/Os: Provide software selectable binary or analog outputs.
- C. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:
 - 1. Output ripple of 5.0 mV maximum peak to peak.
 - 2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
 - 3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.
- D. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:
 - 1. Minimum dielectric strength of 1000 V.
 - 2. Maximum response time of 10 nanoseconds.
 - 3. Minimum transverse-mode noise attenuation of 65 dB.
 - 4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.
- E. UPS Power supply: Provide each Local Control Unit with an independent UPS power supply rated for ten minutes of operation.

2.4 UNITARY CONTROLLERS

- A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.
 - 1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72 hour battery backup.
 - 2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform scheduling with real-time clock. Perform automatic system diagnostics; monitor system and report failures.
 - 3. ASHRAE 135 Compliance: Communicate using read (execute and initiate) and write (execute and initiate) property services defined in ASHRAE 135. Reside on network using MS/TP datalink/physical layer protocol and have service communication port for connection to diagnostic terminal unit.
 - 4. Enclosure: Dustproof rated for operation at 32 to 120 deg F.
 - 5. Enclosure: Waterproof rated for operation at 40 to 150 deg F.
 - 6. UPS power supply: Provide each Unitary controller with a UPS power supply rated for two minutes to maintain controller memory and communications with the BCS during a loss of power.

2.5 ALARM PANELS

- A. Unitized cabinet with suitable brackets for wall or floor mounting. Fabricate of 0.06-inch- thick, furniture-quality steel or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with manufacturer's standard shop-painted finish. Provide common keying for all panels.
- B. Indicating light for each alarm point, single horn, acknowledge switch, and test switch, mounted on hinged cover.
 - 1. Alarm Condition: Indicating light flashes and horn sounds.
 - 2. Acknowledge Switch: Horn is silent and indicating light is steady.
 - 3. Second Alarm: Horn sounds and indicating light is steady.
 - 4. Alarm Condition Cleared: System is reset and indicating light is extinguished.
 - 5. Contacts in alarm panel allow remote monitoring by independent alarm company.

2.6 TIME CLOCKS

- A. Manufacturers:
 - 1. Grasslin Controls Corporation.
 - 2. Paragon Electric Co., Inc.
 - 3. Time Mark Corporation.
- B. Solid-state, programmable time control with 8 separate programs each with up to 100 on-off operations; 1-second resolution; lithium battery backup; keyboard interface and manual override; individual on-off-auto switches for each program; 365-day calendar with 20 programmable

holidays; choice of fail-safe operation for each program; system fault alarm; and communications package allowing networking of time controls and programming from PC.

2.7 ELECTRONIC SENSORS

- A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.
- B. Thermistor Temperature Sensors and Transmitters:
 - 1. Manufacturers:
 - a. BEC Controls Corporation.
 - b. Ebtron, Inc.
 - c. Heat-Timer Corporation.
 - d. I.T.M. Instruments Inc.
 - e. MAMAC Systems, Inc.
 - f. RDF Corporation.
 - 2. Accuracy: Plus or minus 0.5 deg F at calibration point.
 - 3. Wire: Twisted, shielded-pair cable.
 - 4. Insertion Elements in Ducts: Single point, 8 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft..
 - 5. Averaging Elements in Ducts: 36 inches long, flexible; use at all cooling coil locations to temperature or where stratification occurs or where ducts are larger than 10 sq. ft.
 - 6. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches.
 - 7. Outside-Air Sensors: Watertight inlet fitting, shielded from dire
 - 8. Room Sensor Cover Construction: Manufacturer's standard lo ct sunlight.
 - 9. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.
- C. RTDs and Transmitters:
 - 1. Manufacturers:
 - a. BEC Controls Corporation.
 - b. MAMAC Systems, Inc.
 - c. RDF Corporation.
 - 2. Accuracy: Plus or minus 0.2 percent at calibration point.
 - 3. Wire: Twisted, shielded-pair cable.
 - 4. Insertion Elements in Ducts: Single point, 8 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft..
 - 5. Averaging Elements in Ducts: 18 inches long, rigid; use where prone to temperature stratification or where ducts are larger than 9 sq. ft.; length as required.
 - 6. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches.
 - 7. Room Sensor Cover Construction: Manufacturer's standard locking covers.
 - a. Set-Point Adjustment: Concealed.

- b. Set-Point Indication: Exposed.
- c. Thermometer: Exposed.
- 8. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
- 9. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.
- D. Humidity Sensors: Bulk polymer sensor element.
 - 1. Manufacturers:
 - a. BEC Controls Corporation.
 - b. General Eastern Instruments.
 - c. MAMAC Systems, Inc.
 - d. ROTRONIC Instrument Corp.
 - e. TCS/Basys Controls.
 - f. Vaisala.
 - 2. Accuracy: 2 percent full range with linear output.
 - 3. Room Sensor Range: 20 to 80 percent relative humidity.
 - 4. Room Sensor Cover Construction: Manufacturer's standard locking covers.
 - a. Set-Point Adjustment: Exposed.
 - b. Set-Point Indication: Concealed.
 - c. Thermometer: Concealed.
 - 5. Duct Sensor: 20 to 80 percent relative humidity range with element guard and mounting plate.
 - 6. Outside-Air Sensor: 20 to 80 percent relative humidity range with mounting enclosure, suitable for operation at outdoor temperatures of 32 to 120 deg F.
 - 7. Duct and Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.
- E. Pressure Transmitters/Transducers:
 - 1. Manufacturers:
 - a. BEC Controls Corporation.
 - b. General Eastern Instruments.
 - c. MAMAC Systems, Inc.
 - d. ROTRONIC Instrument Corp.
 - e. TCS/Basys Controls.
 - f. Vaisala.
 - 2. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
 - a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
 - b. Output: 4 to 20 mA.

- c. Building Static-Pressure Range: 0- to 0.25-inch wg.
- d. Duct Static-Pressure Range: 0- to 5-inch wg.
- 3. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure; linear output 4 to 20 mA.
- 4. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure and tested to 300-psig; linear output 4 to 20 mA.
- 5. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.
- 6. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA.
- F. Room Sensor Cover Construction: Manufacturer's standard locking covers.
 - 1. Set-Point Adjustment: Concealed.
 - 2. Set-Point Indication: Exposed.

2.8 STATUS SENSORS

- A. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg.
- B. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig, piped across pump.
- C. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.
- D. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.
- E. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.
- F. Current Switches: Auto-calibrating, self-powered, microprocessor based with auto-calibrating trip current, selected to match current and system output requirements to indicate motor status for both under-current (broken belt, mechanical failure) and over-current (locked rotor) conditions. Automatic adjustable trip point of 3.5 to 100 Amps, provided with five-year manufacturer's warranty. Current switch shall be equal to Veris Industries, Hawkeye TruStat H10F.
- G. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
- H. Water-Flow Switches: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.

- 1. Manufacturers:
 - a. BEC Controls Corporation.
 - b. I.T.M. Instruments Inc.
 - c. United Electric
 - d. Johnson Controls/Penn

2.9 GAS DETECTION EQUIPMENT

- A. Manufacturers:
 - 1. Ebtron, Inc.
 - 2. Honeywell International Inc.; Home & Building Control.
 - 3. MSA Canada Inc.
 - 4. QEL/Quatrosense Environmental Limited.
 - 5. Sensidyne, Inc.
 - 6. TSI Incorporated.
 - 7. Vaisala.
 - 8. Vulcain Inc.
- B. Carbon Monoxide Detectors: Single or multichannel, dual-level detectors using solid-state plug-in sensors with a 3-year minimum life; suitable over a temperature range of 32 to 104 deg F; with 2 factory-calibrated alarm levels at 50 and 100 ppm.
- C. Carbon Dioxide Sensor and Transmitter: Single detectors using solid-state infrared sensors; suitable over a temperature range of 23 to 130 deg F and 100 2000 ppm and calibrated for 0 to 2 percent, with continuous or averaged reading, 4- to 20-mA output; for duct mounting.
- D. Oxygen Sensor and Transmitter: Single detectors using solid-state zircon cell sensing; suitable over a temperature range of minus 32 to plus 1100 deg F and calibrated for 0 to 5 percent, with continuous or averaged reading, 4- to 20-mA output; for wall mounting.
- E. Occupancy Sensor: Passive infrared, with time delay, daylight sensor lockout, sensitivity control, and 180-degree field of view with vertical sensing adjustment; for flush mounting.

2.10 FLOW MEASURING STATIONS

- A. Duct Airflow Stations: Products included in this Section:
 - 1. Duct and plenum mounted airflow measurement devices.
 - 2. Fan inlet mounted airflow measurement devices.
- B. Acceptable Manufacturers:
 - 1. Subject to compliance with requirements of this Section, provide products that comply with this specification by one of the following vendors:
 - a. EBTRON, Inc., Model GTx116-P and GTxx116-F (basis of design).
- C. Airflow/Temperature Measurement Devices:
 - 1. Provide airflow/temperature measurement devices (ATMD) where indicated on the plans: a. Fan inlet measurement devices shall not be substituted for duct or plenum
 - a. Fan inlet measurement devices shall not be substituted for duct or plenum measurement devices indicated on the plans.

- 2. Each ATMD shall consist of one or more sensor probes and a single, remotely mounted, microprocessor based transmitter capable of independently processing up to 16 independently wired sensor assemblies:
 - a. Each sensor assembly shall contain two individually wired, hermetically sealed bead in glass thermistors.
 - b. Thermistors shall be mounted in the sensor assembly using a marine grade, waterproof epoxy. Thermistor leads shall be protected and not exposed to the environment.
 - c. The airflow rate of each sensor assembly shall be equally weighted and averaged by the transmitter prior to output.
 - d. The temperature of each sensor assembly shall be velocity weighted and averaged by the transmitter prior to output.
 - e. Each transmitter shall have a 16 character alpha numeric display capable of displaying airflow, temperature, system status, configuration settings and diagnostics.
 - f. Devices using chip in glass or diode case chip thermistors are not acceptable.
 - g. Devices using less than two thermistors in each sensor assembly are not acceptable.
 - h. Devices using platinum wire RTDs are not acceptable.
 - i. Devices having electronic circuitry mounted in or at the sensor probe are not acceptable.
 - j. Pitot tubes and arrays are not acceptable.
- D. All Sensor Probes:
 - 1. Each sensor assembly shall independently determine the airflow rate and temperature at each measurement point.
 - 2. Each sensor assembly shall be calibrated at a minimum of 16 airflow rates and 3 temperatures to standards that are traceable to the National Institute of Standards and Technology (NIST).
 - 3. Airflow accuracy shall be +/- 2% of reading over the entire operating airflow range:
 - a. Devices whose accuracy is the combined accuracy of the transmitter and sensor probes must demonstrate that the total accuracy meets the performance requirements of this specification throughout the measurement range.
 - Temperature accuracy shall be +/- 0.15° F over the entire operating temperature range of -20° F to 160°F.
 - 5. The operating humidity range for each sensor probe shall be 0-99% RH (non-condensing).
 - 6. Each sensor probe shall have an integral, U.L. listed, plenum rated cable and terminal plug for connection to the remotely mounted transmitter. All terminal plug interconnecting pins shall be gold plated.

- 7. Each sensor assembly shall not require matching to the transmitter in the field.
- 8. A single manufacturer shall provide both the airflow/temperature measuring probe(s) and transmitter for each measurement location.
- E. Duct and Plenum Probes:
 - 1. Probes shall be constructed of extruded, gold anodized, 6063 aluminum tube. All wires within the aluminum tube shall be Kynar coated.
 - 2. Probe assembly mounting brackets shall be constructed of 304 stainless steel. Probe assemblies shall be mounted using one of the following options:
 - a. Insertion mounted through the side or top of the duct.
 - b. Internally mounted inside the duct or plenum.
 - c. Standoff mounted inside the plenum.
- 3. The number of sensor housings provided for each location shall be as follows:

Duct or Plenum Area (sq.ft.)	Total # Sensors/Location
<2	4
2 to <4	6
4 to <8	8
8 to <16	12
>=16	16

- 4. The operating airflow range shall be 0 to 5,000 FPM unless otherwise indicated on the plans.
- F. Fan Inlet Probes:
 - 1. Sensor assemblies shall be mounted on 304 stainless steel housings.
 - 2. Mounting rods shall be field adjustable to fit the fan inlet and constructed of nickel plated steel.
 - 3. Mounting feet shall be constructed of 304 stainless steel.
 - 4. The operating airflow range shall be 0 to 10,000 FPM unless otherwise indicated on the plans.
- G. Transmitters:
 - 1. The transmitter shall have in integral LCD display capable of simultaneously displaying airflow and temperature. The LCD display shall be capable of displaying individual airflow and temperature readings of each independent sensor assembly.
 - 2. The transmitter shall be capable of field configuration and diagnostics using an onboard pushbutton interface and LCD display.
 - 3. The transmitter shall have a power switch and operate on 24 VAC (isolation not required):
 - a. The transmitter shall use a switching power supply fused and protected from transients and power surges.

- b. The transmitter shall use "watch dog" circuitry to assure reset after power disruption, transients and brown-outs.
- 4. All interconnecting pins, headers and connections on the main circuit board, option cards and cable receptacles shall be gold plated.
- 5. The operating temperature range for the transmitter shall be -20° F to 120° F. The transmitter shall be installed at a location that is protected from weather and water.
- 6. The transmitter shall be capable of communicating with other devices using one of the following interface options:
 - a. Linear analog output signals for airflow and temperature: Field selectable, fuse protected and isolated, 0-10VDC/4-20mA (4 wire).
 - b. RS-485: Field selectable BACnet-ARCNET, BACnet-MS/TP, Modbus RTU or Johnson Controls N2 Bus.
 - 1) BACnet devices shall provide analog variables for airflow and temperature containing individual sensor airflow rate and temperature data.
- 7. The transmitter shall be capable of accepting an infra-red interface card for downloading airflow and temperature data or uploading transmitter configuration data using a handheld PDA (Palm or Microsoft Windows Mobile operating systems).
 - a. Provide PDA upload/download software:
 - 1) Download software shall be capable of displaying and saving individual sensor airflow rates, the average airflow rate, individual sensor temperatures and the average temperature received from the transmitter.
 - 2) Upload software shall be capable of displaying and saving all setup parameters that can be configured using the on-board pushbutton interface and LCD display.
 - b. Provide a Microsoft Excel file capable of creating balance reports from PDA data files transferred to a Windows 98 or higher based PC.
 - c. Provide a Microsoft Excel file to create configuration data files that can be transferred from a Windows 2000, Windows XP or higher based PC to PDA for upload to one or more transmitters.
- H. The ATMD shall be UL listed as an entire assembly.
- I. The manufacturer's authorized representative shall review and approve placement and operating airflow rates for each measurement location indicated on the plans.
 - 1. A written report shall be submitted to the engineer if any measurement locations do not meet the manufacturer's placement requirements.
- J. Install airflow/temperature measurement devices in accordance with manufacturer's instructions at the locations indicated on the plans:
 - 1. A written report shall be submitted to the consulting mechanical engineer if any discrepancies are found.

- K. Install labels and nameplates to identify control components according to Section 23 3300 or 253500.
- L. Install electronic cables according to Section 25 0500 "Common Work Results for Integrated Automation".
- M. Install low voltage power, signal and communication cable according to Sections 250513 "Conductors and Cables for Integrated Automation", 260519 "Low Voltage Electrical Power Conductors and Cables", and/or 271500 "Communication Horizontal Cabling".
- N. Duct and plenum devices shall not be adjusted without approval from the consulting mechanical engineer.

2.11 WATER FLOW METERS

- A. Electromagnetic Flow Meters:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Onicon Incorp.
 - 2. Description: Flowmeter with sensor and indicator.
 - 3. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
 - 4. Sensor: Insertion type; for inserting probe into piping and measuring flow directly in gallons per minute.
 - a. Design: Differential-pressure-type measurement for water.
 - b. Construction: Stainless-steel probe of length to span inside of pipe, with integral transmitter and direct-reading scale.
 - c. Minimum Pressure Rating: 150 psig.
 - d. Minimum Temperature Rating: 250 deg F.
 - 5. Indicator: Hand-held meter; either an integral part of sensor or a separate meter.
 - 6. Integral Transformer: For low-voltage power connection.
 - 7. Accuracy: Plus or minus 1 percent.
 - 8. Display: Shows rate of flow, with register to indicate total volume in gallons.
 - 9. Operating Instructions: Include complete instructions with each flowmeter.
- B. Pitot-Tube Flow Meters:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABB; Instrumentation and Analytical.
 - b. Emerson Process Management; Rosemount.
 - c. Meriam Process Technologies.
 - d. Preso Meters; a division of Racine Federated Inc.
 - e. TACO Incorporated.
 - f. Veris Industries, Inc.

- 2. Description: Flowmeter with sensor and indicator.
- 3. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
- 4. Sensor: Insertion type; for inserting probe into piping and measuring flow directly in gallons per minute.
 - a. Design: Differential-pressure-type measurement for water.
 - b. Construction: Stainless-steel probe of length to span inside of pipe, with integral transmitter and direct-reading scale.
 - c. Minimum Pressure Rating: 150 psig.
 - d. Minimum Temperature Rating: 250 deg F.
- 5. Indicator: Hand-held meter; either an integral part of sensor or a separate meter.
- 6. Integral Transformer: For low-voltage power connection.
- 7. Accuracy: Plus or minus 3 percent.
- 8. Display: Shows rate of flow, with register to indicate total volume in gallons.
- 9. Operating Instructions: Include complete instructions with each flowmeter.
- C. Turbine Flowmeters:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABB; Instrumentation and Analytical.
 - b. Data Industrial Corp.
 - c. EMCO Flow Systems; a division of Spirax Sarco, Inc.
 - d. ERDCO Engineering Corp.
 - e. Hoffer Flow Controls, Inc.
 - f. Liquid Controls; a unit of IDEX Corporation.
 - g. McCrometer, Inc.
 - h. Midwest Instruments & Controls Corp.
 - i. ONICON Incorporated.
 - j. SeaMetrics, Inc.
 - k. Sponsler, Inc.; a unit of IDEX Corporation.
 - 2. Description: Flowmeter with sensor and indicator.
 - 3. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
 - 4. Sensor: Impeller turbine; for inserting into pipe fitting or for installing in piping and measuring flow directly in gallons per minute.
 - a. Design: Device or pipe fitting with inline turbine and integral direct-reading scale for water.
 - b. Construction: Bronze or stainless-steel body, with plastic turbine or impeller.
 - c. Minimum Pressure Rating: 150 psig.
 - d. Minimum Temperature Rating: 180 deg F.

- 5. Indicator: Hand-held meter; either an integral part of sensor or a separate meter.
- 6. Accuracy: Plus or minus 1-1/2 percent.
- 7. Display: Shows rate of flow, with register to indicate total volume in gallons.
- 8. Operating Instructions: Include complete instructions with each flowmeter.

D. Venturi Flowmeters:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABB; Instrumentation and Analytical.
 - b. Gerand Engineering Co.
 - c. Hyspan Precision Products, Inc.
 - d. Preso Meters; a division of Racine Federated Inc.
 - e. S. A. Armstrong Limited; Armstrong Pumps Inc.
 - f. Victaulic Company.
- 2. Description: Flowmeter with calibrated flow-measuring element, hoses or tubing, fittings, valves, indicator, and conversion chart.
- 3. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
- 4. Sensor: Venturi-type, calibrated, flow-measuring element; for installation in piping.
 - a. Design: Differential-pressure-type measurement for water.
 - b. Construction: Bronze, brass, or factory-primed steel, with brass fittings and attached tag with flow conversion data.
 - c. Minimum Pressure Rating: 250 psig.
 - d. Minimum Temperature Rating: 250 deg F.
 - e. End Connections for NPS 2 and Smaller: Threaded.
 - f. End Connections for NPS 2-1/2 and Larger: Flanged or welded.
 - g. Flow Range: Flow-measuring element and flowmeter shall cover operating range of equipment or system served.
- 5. Permanent Indicators: Meter suitable for wall or bracket mounting, calibrated for connected flowmeter element, and having 6-inch- diameter, or equivalent, dial with fittings and copper tubing for connecting to flowmeter element.
 - a. Scale: Gallons per minute.
 - b. Accuracy: Plus or minus 1 percent between 20 and 80 percent of scale range.
- 6. Display: Shows rate of flow, with register to indicate total volume in gallons.
- 7. Conversion Chart: Flow rate data compatible with sensor.
- 8. Operating Instructions: Include complete instructions with each flowmeter.
- E. Flow meters shall be Ultrasonic type flow meters as specified in Section 23 0519.

2.12 THERMOSTATS

- A. Manufacturers:
 - 1. Erie Controls.

- 2. Danfoss Inc.; Air-Conditioning and Refrigeration Div.
- 3. Heat-Timer Corporation.
- 4. Sauter Controls Corporation.
- 5. Tekmar Control Systems, Inc.
- 6. Theben AG Lumilite Control Technology, Inc.
- B. Combination Thermostat and Fan Switches: Line-voltage thermostat with push-button or leveroperated fan switch.
 - 1. Label switches "FAN ON-OFF".
 - 2. Mount on single electric switch box.
- C. Wireless, microcomputer-based room thermostat with remote sensor.
 - 1. Automatic switching from heating to cooling.
 - 2. Preferential rate control to minimize overshoot and deviation from set point.
 - 3. Set up for four separate temperatures per day.
 - 4. Instant override of set point for continuous or timed period from 1 hour to 31 days.
 - 5. Short-cycle protection.
 - 6. Programming based on weekday, Saturday, and Sunday.
 - 7. Selection features include degree F or degree C display, 12- or 24-hour clock, keyboard disable, remote sensor, and fan on-auto.
 - 8. Battery replacement without program loss.
 - 9. Thermostat display features include the following:
 - a. Time of day.
 - b. Actual room temperature.
 - c. Programmed temperature.
 - d. Programmed time.
 - e. Duration of timed override.
 - f. Day of week.
 - g. System mode indications include "heating," "off," "fan auto," and "fan on."
- D. Wireless, On-Off Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed set-point adjustment, 55 to 85 deg F set-point range, and 2 deg F maximum differential.
- E. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch or equivalent solid-state type, with heat anticipator; listed for electrical rating; with concealed set-point adjustment, 55 to 85 deg F set-point range, and 2 deg F maximum differential.
 - 1. Electric Heating Thermostats: Equip with off position on dial wired to break ungrounded conductors.
 - 2. Selector Switch: Integral, manual on-off-auto.

- F. Remote-Bulb Thermostats: On-off or modulating type, liquid filled to compensate for changes in ambient temperature; with copper capillary and bulb, unless otherwise indicated.
 - 1. Bulbs in water lines with separate wells of same material as bulb.
 - 2. Bulbs in air ducts with flanges and shields.
 - 3. Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit; adequately supported.
 - 4. Scale settings and differential settings are clearly visible and adjustable from front of instrument.
 - 5. On-Off Thermostat: With precision snap switches and with electrical ratings required by application.
 - 6. Modulating Thermostats: Construct so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.
- G. Fire-Protection Thermostats: Listed and labeled by an NRTL acceptable to authorities having jurisdiction; with fixed or adjustable settings to operate at not less than 75 deg F above normal maximum operating temperature, and the following:
 - 1. Reset: Manual.
 - 2. Reset: Automatic, with control circuit arranged to require manual reset at central control panel; with pilot light and reset switch on panel labeled to indicate operation.
- H. Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable set point.
- I. Airstream Thermostats: Two-pipe, fully proportional, single-temperature type; with adjustable set point in middle of range, adjustable throttling range, plug-in test fitting or permanent pressure gage, remote bulb, bimetal rod and tube, or averaging element.
- J. Electric, Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below set point.
 - 1. Bulb Length: Minimum 20 feet.
 - 2. Quantity: One thermostat for every 20 sq. ft. of coil surface.
- K. Electric, High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or above set point.
 - 1. Bulb Length: Minimum 20 feet.
 - 2. Quantity: One thermostat for every 20 sq. ft. of coil surface.

2.13 HUMIDISTATS

- A. Manufacturers:
 - 1. MAMAC Systems, Inc.
 - 2. ROTRONIC Instrument Corp.

B. Duct-Mounting Humidistats: Electric insertion, 2-position type with adjustable, 2 percent throttling range, 20 to 80 percent operating range, and single- or double-pole contacts.

2.14 ACTUATORS

- A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
 - 1. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 - 2. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
 - 3. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
 - 4. Spring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running and breakaway torque of 150 in. x lbf.
 - 5. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
 - 6. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.
- B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
 - 1. Manufacturers: Belimo Aircontrols (USA), Inc.
 - 2. Valves: Size for torque required for valve close off at maximum pump differential pressure.
 - 3. Dampers: Size for running torque calculated as follows:
 - a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
 - b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
 - c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft of damper.
 - d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
 - e. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
 - f. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.
 - 4. Coupling: V-bolt and V-shaped, toothed cradle.
 - 5. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
 - 6. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
 - 7. Power Requirements (Two-Position Spring Return): 24 V ac.
 - 8. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
 - 9. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.

- 10. Temperature Rating: Minus 22 to plus 122 deg F.
- 11. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F.
- 12. Run Time: 12 seconds open, 5 seconds closed.

2.15 CONTROL VALVES

- A. Manufacturers:
 - 1. Belimo
 - 2. Delta P
- B. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.
- C. Hydronic system globe valves shall have the following characteristics:
 - 1. NPS 2 and Smaller: Class 250 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.
 - 2. NPS 2-1/2 and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.
 - 3. Internal Construction: Replaceable plugs and stainless-steel or brass seats.
 - a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom.
 - b. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom.
 - 4. Sizing: 3- to 5-psig maximum pressure drop at design flow rate or the following:
 - a. Two Position: Line size.
 - b. Two-Way Modulating: Either the value specified above or twice the load pressure drop, whichever is more.
 - c. Three-Way Modulating: Twice the load pressure drop, but not more than value specified above.
 - 5. Flow Characteristics: Two-way valves shall have equal percentage characteristics; threeway valves shall have linear characteristics.
 - 6. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump) head for two-way valves and 100 percent of pressure differential across valve or 100 percent of total system (pump) head.
- D. Pressure Independent Characterized Control Valves: Pressure independent control valves shall be permitted in lieu of two-way control valve and circuit setter balancing valve with flow control valve.
 - 1. Manufacturers:
 - a. Belimo Aircontrols (USA), Inc.

- b. Griswold
- c. Delta P
- 2. The modulating control valves shall be pressure independent.
- 3. The control valves shall accurately control the flow from 0 to 100% full rated flow with an equal percentage flow characteristic. The flow shall not vary more than +/- 5% due to system pressure fluctuations across the valve with a minimum of 5 PSID across the valve.
- 4. Forged brass body rated at no less than 400 PSI, chrome plated brass ball and stem, female NPT union ends, dual EPDM lubricated O-rings and TEFZEL characterizing disc.
- 5. Combination of actuator and valve shall provide a minimum close-off pressure rating of 200 PSID.
- 6. All actuators shall be electronically programmed by use of a handheld programming device or external computer software. Programming using actuator mounted switches or multi-turn actuators are NOT acceptable. Actuators shall be provided with an auxiliary switch to prove valve position.
- 7. The actuator shall be the same manufacturer as the valve, integrally mounted to the valve at the factory via a single screw on a four-way DIN mounting base.
- 8. The control valve shall require no maintenance and shall not include replaceable cartridges.
- 9. The manufacturer shall warrant all components for a period of 5 years from the date of production, with the first two years unconditional.
- 10. The use of pressure independent valves piped in parallel to achieve the rated coil flow shall be permitted. Actuators shall be electronically programmed to permit sequencing the flow with a single control output point. The use of external devices to permit sequencing is NOT acceptable.
- E. Butterfly Valves: 200-psig, 150-psig maximum pressure differential, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.
 - 1. Body Style: Wafer.
 - 2. Disc Type: Aluminum bronze.
 - 3. Sizing: 1-psig maximum pressure drop at design flow rate.
 - 4. Provide three-way valves larger than 6" using a standard flanged tee and two butterfly valves linked together to operate from one actuator in unison.
- F. Terminal Unit Control Valves: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.
 - 1. Rating: Class 125 for service at 125 psig and 250 deg F operating conditions.
 - 2. Sizing: 3-psig maximum pressure drop at design flow rate, to close against pump shutoff head.
 - 3. Flow Characteristics: Two-way valves shall have equal percentage characteristics; threeway valves shall have linear characteristics.

4. Actuators shall be fully modulating, analog control valves. Tri-state actuators shall not be allowed.

2.16 DAMPERS

- A. Manufacturers:
 - 1. Air Balance Inc.
 - 2. Don Park Inc.; Autodamp Div.
 - 3. TAMCO (T. A. Morrison & Co. Inc.).
 - 4. United Enertech Corp.
 - 5. Vent Products Company, Inc.
 - 6. Ruskin
- B. Dampers: AMCA-rated, opposed blade design; 0.108-inch- minimum thick, galvanized-steel or 0.125-inch- minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch- thick galvanized steel with maximum blade width of 8 inches and length of 48 inches.
 - 1. Secure blades to 1/2-inch- diameter, zinc-plated axles using zinc-plated hardware, with oilimpregnated sintered bronze blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
 - 2. Operating Temperature Range: From minus 40 to plus 200 deg F.
 - 3. Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 10 cfm per sq. ft. of damper area, at differential pressure of 4-inch wg when damper is held by torque of 50 in. x lbf; when tested according to AMCA 500D.

2.17 CONTROL CABLE

A. Electronic and fiber-optic cables for control wiring are specified in Division 27 Section "Communications Horizontal Cabling."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that conditioned power supply is available to control units and operator workstation.
- B. Verify that pneumatic piping and duct-, pipe-, and equipment-mounted devices are installed before proceeding with installation.

3.2 INSTALLATION

- A. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.
- B. Connect and configure equipment and software to achieve sequence of operation specified.
- C. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above the floor.
 - 1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

- D. Install guards on thermostats in the following locations:
 - 1. Where indicated.
- E. Install automatic dampers according to Division 23 Section "Air Duct Accessories."
- F. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.
- G. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."
- H. Install hydronic instrument wells, valves, and other accessories according to Division 23 Section "Hydronic Piping."
- I. Install refrigerant instrument wells, valves, and other accessories according to Division 23 Section "Refrigerant Piping."
- J. Install duct volume-control dampers according to Division 23 Sections specifying air ducts.
- K. Install electronic and fiber-optic cables according to Division 27 Section "Communications Horizontal Cabling."

3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."
- B. Install building wire and cable according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- C. Install signal and communication cable according to Division 27 Section "Communications Horizontal Cabling."
 - 1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
 - 2. Install exposed cable in raceway.
 - 3. Install concealed cable in raceway.
 - 4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
 - 5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
 - 6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
 - 7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
- D. Connect manual-reset limit controls independent of manual-control switch positions.

- E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.
- F. Coordinate wireless device rough in requirements with controls manufacturer/contractor.

3.4 ADJUSTING

- A. Calibrating and Adjusting:
 - 1. Calibrate instruments.
 - 2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
 - 3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
 - 4. Control System Inputs and Outputs:
 - a. Check analog inputs at 0, 50, and 100 percent of span.
 - b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
 - c. Check digital inputs using jumper wire.
 - d. Check digital outputs using ohmmeter to test for contact making or breaking.
 - e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.
 - 5. Flow:
 - a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
 - b. Manually operate flow switches to verify that they make or break contact.
 - 6. Pressure:
 - a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
 - b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
 - 7. Temperature:
 - a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
 - b. Calibrate temperature switches to make or break contacts.
 - 8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.

- 9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
- 10. Provide diagnostic and test instruments for calibration and adjustment of system.
- 11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.
- B. Adjust initial temperature and humidity set points.
- C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

3.5 TESTING, CALIBRATION, AND ACCEPTANCE

- A. After the inspection has been completed, systems shall be checked for continuity.
- B. After completion of the installation, control equipment shall be tested and adjusted in terms of design, function, systems balance, alarms, and performance, and shall otherwise be made ready for systems acceptance tests. Data showing set points and final adjustments of controls shall be provided.
- C. After air handling system acceptance and after the systems have operated in normal service for 2 weeks, the adjustment on instruments and devices shall be checked. Items found to be out of order shall be corrected. When air-handling systems are in specified operating condition and when all other pertinent specification requirements have been met, automatic temperature-control systems will be accepted.
- D. Equipment to check the calibration of instruments shall be provided by the Contractor. Instruments not in calibration shall be recalibrated or replaced.
- E. System Start-up and Check-out:
 - 1. The manufacturer shall provide a control technician for the start-up, checkout of all input and outputs, implement and check the software function and submit report on check-out of each system.
 - 2. Demonstrate to the Owner that all functions are operating as per final approved sequences.
- F. System Acceptance & Trend Log Submittal:
 - 1. Historical Trending:
 - a. Software shall provide historical trend information for operator-selected points. Operator shall be able to assign any system point, analog or binary, real or calculated, to trend group. Trend groups shall consist of single point or multiple point groups. Trended values shall be retained in system storage. Operator shall be able to request retrieval of trended values from storage and printing at time.
 - b. After completion of the installation, check-out and control loop tuning, trend logs, shall be enabled and upon completion submitted, as listed below, to demonstrate the satisfactory performance of the system and to serve as a database for the owner's future use.

- c. The trend logs shall be organized in spreadsheet format and presented in both tabular and graphical form. A disc copy of each final accepted trend log set shall also be provided. Trend logs shall be as follows:
- 2. Control Stability Trend Logs:
 - a. Each digital or analog output to valves, dampers, adjustable frequency drives and other control devices shall be included.
 - b. Scan time shall be at five-second intervals for a duration of ten minutes.
 - c. Start of the sets shall be immediately after change from one mode to another, i.e., unoccupied to occupied, no economizer to economizer, "Off" to "On", etc. Only one log will be required for each output as long as it addresses all controlled elements.
- 3. System Operation Trend Logs:
 - a. Each measured value (temperature, pressure, amps, etc.), equipment status (on-off, percent speed or position, etc.), each mode (unoccupied, cool-down, occupied, etc.), each setpoint and each alarm shall be included.
 - b. Scan time shall be at one minute intervals with a duration of 24 hours.
 - c. Sets shall be included for cooling only, cooling plus economizer and heating only. Where start up occurs at a defined season and both heating and cooling cannot be logged, then the system will be accepted subject to a final demonstration of the other season, when weather permits.
- 4. Load Profile Trend Log Sets:
 - a. The total AHU load in tons shall be calculated using airflow and temperature difference between supply and return air.
 - b. Tonnage shall be calculated by averaging six instantaneous readings per hour taken at ten minute intervals. Tonnage for each of the 24 hours shall be listed.
- 5. Energy Use Trend Log Sets:
 - a. Energy use of each fan shall be calculated using measured amps and a look-up table provided by the motor manufacturer to convert to kW.
 - b. The sum of all HVAC power use shall be totaled and listed.
 - c. Outdoor air wet-bulb shall be listed.
 - d. Data shall be presented for each of the 24 hours each day.
 - e. Energy use shall be presented in bar graph form.
- 6. Life Safety Trend Logs:
 - a. A separate set of trend logs shall be developed for each life safety/smoke control system/zone. These shall be in the "change of value" format when going from "normal operation" to "emergency operation" and shall show the condition of each input device, fan and damper. Where airflow is measured, as in an engineered smoke control system, the airflow in each possible smoke condition shall be included.

- 7. Custom Trend Log Sets:
 - a. The operator shall have the ability to customize all trend logs by adjusting both sampling time and duration.
 - b. After the initial graph data is accepted, the printout shall be changed from a fixed interval to a change of value.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC Building Control System. Refer to Division 01 Section "Demonstration and Training."

3.7 SPARE PARTS

A. Provide spares of each type and size of control valve actuator and damper actuator, equal to 10% of the quantity of actuators of each type and size.

3.8 UNIT PRICES – SEE ATTACHED.

Additional Building Control System to be included in Scope

General Notes: The following table of quantities are for adding or deleting BCS devices that are not indicated on the plans, however all work associated with furnishing and installing these devices shall be included as part of the Contract. These devices shall be installed as a result changes to the design. It is the intent that the unit price per item includes work associated with an additional device installed when the building is 100% complete, with ceiling tiles in and wall finished. The unit costs associated with these items shall include patching and cutting of the walls, finish work, replacement of ceiling tiles. The value provided shall be included as part of the bid for the work, and the value shall be returned to the owner if device is not installed.

ltem No.	Description of Work	Notes	Units	Estimated Quantity	Unit Price	Total Price
BCS- 1	Direct Digital Control Panel (2.3.C)	Additional DDC Panel. Included in the unit price shall be work associated with the device, 50' of conduit, wire, testing, device programming, and additional accessories as required to provide a functional device.	EA	5		
					\$	\$
BCS- 2	Operator WorkStation (2.3.A)	Operator Work Station Included in the unit price shall be work associated with the device, 50' of conduit, wire, software, testing, device program- ming, and additional accessories as required to provide a functional device Also included shall be cutting and patching of ceiling/ceiling tiles associat- ed with installation of device.	EA	2	\$	\$
BCS- 3	Diagnostic Terminal Unit (2.3.B)	Diagnostic Terminal/Unit finished walls.	EA	2	\$	\$
BCS- 4	Local Unit (2.3.D)	Local Control Unit installed. Included in the unit price shall be work associated with the device, 50' of conduit, wire, testing, device programming, and additional accessories as required to provide a functional device.	EA	10	\$	\$
BCS-	Unitary Con-	Unitary Controller installed in control circuits where	EA	100		
5	troller (2.4)	required. Included in the unit price shall be work associated with 50' of conduit, wire, testing, device programming, and additional accessories as re- quired to provide a functional device.			\$	\$

BCS- 6	BCS Alarm Panel (2.5)		EA	2		
					\$	\$
BCS- 7	BCS Room Temperature Sensor (2.8.B.7)	Include sensor, wiring, conduit, A1 input and pro- gramming up to 50' from control panel.	EA	20	¢	¢
BCS- 8	BCS Duct Temp Sensor (2.8.B.4)	Include sensor, wiring, conduit, A1 input and pro- gramming up to 50' from control panel.	EA	20	\$	<u>م</u>
BCS- 9	BCS Average Duct Temp Sensor (2.8.B.5)	Include sensor, wiring, conduit, A1 input and pro- gramming up to 50' from control panel.	EA	20	\$	\$
BCS- 10	BCS Insertion Element (2.8.B.6)	Includes temperature well and sensor, wiring, con- duit, A1 input and programming up to 50' from con- trol panel.	EA	20	\$	\$
BCS- 11	BCS Humidity Sensor (2.8.D)	Includes temperature well and sensor, wiring, con- duit, A1 input and programming up to 50' from con- trol panel.	EA	10	\$	\$
BCS- 12	BCS Static Pressure Transmitted (2.8.E.2)	Includes temperature well and sensor, wiring, con- duit, A1 input and programming up to 50' from con- trol panel.	EA	10	\$	\$
BCS -13	BCS Water Differential Pressure Transmitter (2.8,E.4)	Includes temperature well and sensor, wiring, con- duit, A1 input and programming up to 50" from con- trol panel.	EA	2	\$	\$
BCS- 14	BCS CO2 Sensor (2.10.C)		EA		*	· ·
					\$	\$

END OF SECTION 23 0900

SECTION 23 2123 HYDRONIC PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Separately coupled, horizontal, in-line centrifugal pumps.
 - 2. Separately coupled, vertical, in-line centrifugal pumps.
 - 3. Separately coupled, base-mounted, end-suction centrifugal pumps.
 - 4. Separately coupled, base-mounted, double-suction centrifugal pumps.
 - 5. Separately coupled, vertical-mounted, double-suction centrifugal pumps.
 - 6. Automatic condensate pump units.

1.3 DEFINITIONS

- A. Buna-N: Nitrile rubber.
- B. EPT: Ethylene propylene terpolymer.

1.4 SUBMITTALS

- A. Product Data: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.
- B. Shop Drawings: Show pump layout and connections. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain hydronic pumps through one source from a single manufacturer.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of hydronic pumps and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
D. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.
- B. Store pumps in dry location.
- C. Retain protective covers for flanges and protective coatings during storage.
- D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.
- E. Comply with pump manufacturer's written rigging instructions.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Mechanical Seals: One mechanical seal(s) for each pump.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection.

2.2 SEPARATELY COUPLED, HORIZONTAL, IN-LINE CENTRIFUGAL PUMPS

- A. Manufacturers:
 - 1. Armstrong Pumps Inc.
 - 2. Bell & Gossett; Div. of ITT Industries.
 - 3. Grundfos Pumps Corporation.
 - 4. Taco, Inc.
- B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally. Rate pump for 175-psig minimum working pressure and a continuous water temperature of 225 deg F.
- C. Pump Construction:
 - 1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, and threaded companion-flange connections.

- 2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, and keyed to shaft. Trim impeller to match specified performance.
- 3. Pump Shaft: Stainless steel.
- 4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainlesssteel spring, and EPT bellows and gasket. Include water slinger on shaft between motor and seal.
- 5. Pump Bearings: Permanently lubricated ball bearings.
- D. Shaft Coupling: Molded rubber insert with interlocking spider capable of absorbing vibration.
- E. Motor: Single speed, with permanently lubricated ball bearings, unless otherwise indicated; and rigidly mounted to pump casing. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.3 SEPARATELY COUPLED, VERTICAL, IN-LINE CENTRIFUGAL PUMPS

- A. Manufacturers:
 - 1. Armstrong Pumps Inc.
 - 2. Bell & Gossett; Div. of ITT Industries.
- B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted vertically. Rate pump for 175-psig minimum working pressure and a continuous water temperature of 225 deg F.
- C. Pump Construction:
 - 1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, and threaded companion-flange connections.
 - 2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
 - 3. Pump Shaft: Stainless steel.
 - 4. In subparagraph below, select first option for temperature rating of 225 deg F (107 deg C); select second option for 250 deg F (121 deg C).
 - 5. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainlesssteel spring, and EPT bellows and gasket. Include water slinger on shaft between motor and seal.
 - 6. Pump Bearings: Permanently lubricated ball bearings.
- D. Shaft Coupling: Axially split spacer coupling.
- E. Motor: Single speed, with permanently lubricated ball bearings, unless otherwise indicated; rigidly mounted to pump casing with lifting eye and supporting lugs in motor enclosure. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.4 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

- A. Manufacturers:
 - 1. Armstrong Pumps Inc.
 - 2. Bell & Gossett; Div. of ITT Industries.
 - 3. Taco, Inc.
- B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal. Rate pump for 175-psig minimum working pressure and a continuous water temperature of 225 deg F.
- C. Pump Construction:
 - 1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and threaded companion-flange connections. Provide integral mount on volute to support the casing, and attached piping to allow removal and replacement of impeller without disconnecting piping or requiring the realignment of pump and motor shaft.
 - 2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
 - 3. Pump Shaft: Stainless steel.
 - 4. In subparagraph below, select first option for temperature rating of 225 deg F (107 deg C); select second option for 250 deg F (121 deg C).
 - 5. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainlesssteel spring, and EPT bellows and gasket.
 - 6. Pump Bearings: Grease-lubricated ball bearings contained in cast-iron housing with grease fittings.
- D. Shaft Coupling: Molded rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor, EPDM coupling sleeve for variable-speed applications.
- E. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.
- F. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.
- G. Motor: Single speed, with permanently lubricated ball bearings, unless otherwise indicated; secured to mounting frame, with adjustable alignment. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.5 SEPARATELY COUPLED, BASE-MOUNTED, DOUBLE-SUCTION CENTRIFUGAL PUMPS

- A. Manufacturers:
 - 1. Armstrong Pumps Inc.
 - 2. Bell & Gossett; Div. of ITT Industries.
 - 3. Taco, Inc.
- B. Description: Factory-assembled and -tested, centrifugal, impeller-between-bearings, separately coupled, double-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal. Rate pump for 175-psig minimum working pressure and a continuous water temperature of 225 deg F.
- C. Pump Construction:
 - 1. Casing: Horizontally split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and ASME B16.1, Class 250 flanges. Casing supports shall allow removal and replacement of impeller without disconnecting piping.
 - 2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, and keyed to shaft. Trim impeller to match specified performance.
 - 3. Pump Shaft: Stainless steel.
 - 4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainlesssteel spring, and EPT bellows and gasket.
 - 5. Pump Bearings: Grease-lubricated ball bearings contained in cast-iron housing with grease fittings.
- D. Shaft Coupling: Molded rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor, EPDM coupling sleeve for variable-speed applications.
- E. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.
- F. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.
- G. Motor: Single speed, with grease-lubricated ball bearings, unless otherwise indicated; secured to mounting frame, with adjustable alignment. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.6 SEPARATELY COUPLED, VERTICAL-MOUNTED, DOUBLE-SUCTION CENTRIFUGAL PUMPS

- A. Manufacturers:
 - 1. Armstrong Pumps Inc.
 - 2. Bell & Gossett; Div. of ITT Industries.
 - 3. Taco, Inc.

Project No. 121505 Hydronic Pumps Section 23 2123 - 5

- B. Description: Factory-assembled and -tested, centrifugal, impeller-between-bearings, separately coupled, double-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted vertically. Rate pump for 175-psig minimum working pressure and a continuous water temperature of 225 deg F.
- C. Pump Construction:
 - 1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, drain plug at bottom of volute, mounting support, and ASME B16.1, Class 250 flanges.
 - 2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, and keyed to shaft. Trim impeller to match specified performance.
 - 3. Pump Shaft: Stainless steel.
 - 4. In subparagraph below, select first option for temperature rating of 225 deg F (107 deg C); select second option for 250 deg F (121 deg C).
 - 5. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainlesssteel spring, and EPT bellows and gasket.
 - 6. Pump Bearings: Grease-lubricated ball bearings contained in cast-iron housing with grease fittings.
- D. Shaft Coupling: Molded rubber insert and interlocking spider capable of absorbing vibration.
- E. Motor: Single speed, with grease-lubricated ball bearings, unless otherwise indicated; secured to casing. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.7 AUTOMATIC CONDENSATE PUMP UNITS

- A. Manufacturers:
 - 1. Little Giant Pump Co.; Subsidiary of Tecumseh Products Co.
- B. Description: Packaged units with corrosion-resistant pump, plastic tank with cover, and automatic controls. Include factory- or field-installed check valve and a 72-inch-minimum, electrical power cord with plug.

2.8 PUMP SPECIALTY FITTINGS

- A. Suction Diffuser: Angle pattern, 175-psig pressure rating, ductile iron body and end cap, pump-inlet fitting; with bronze startup and bronze or stainless-steel permanent strainers; bronze or stainless-steel straightening vanes; drain plug; and factory-fabricated support.
 - 1. Manufacturers:
 - a. Bell and Gossett
 - b. Armstrong

B. Triple-Duty Valve: For pumps with discharge line 6" or less, provide triple duty valves with angle or straight pattern, 175-psig pressure rating, ductile iron body, pump-discharge fitting; with drain plug and bronze-fitted shutoff, balancing, and check valve features. Brass gage ports with integral check valve, and orifice for flow measurement. For pumps with discharge line greater than 6", provide individual isolation valve, check valve and balancing valve.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
- C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONCRETE BASES

- A. Install concrete bases of dimensions indicated for pumps and controllers. Refer to Division 23 Section "Common Work Results for HVAC."
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
 - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
- B. Cast-in-place concrete materials and placement requirements are specified in Division 03.

3.3 PUMP INSTALLATION

- A. Comply with HI 1.4.
- B. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.
- C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

- D. Install continuous-thread hanger rods and spring hangers of sufficient size to support pump weight. Vibration isolation devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Fabricate brackets or supports as required. Hanger and support materials are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- E. Suspend vertically mounted, in-line centrifugal pumps independent of piping. Install pumps with motor and pump shafts vertical. Use continuous-thread hanger rods and spring hangers of sufficient size to support pump weight. Vibration isolation devices are specified in Division 21 Section "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment." Hanger and support materials are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment/Hangers and Supports for HVAC Piping and Equipment."
- F. Set base-mounted pumps on concrete foundation. Disconnect coupling before setting. Do not reconnect couplings until alignment procedure is complete.
 - Support pump baseplate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1-1/2 inches between pump base and foundation for grouting.
 - 2. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.
- G. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.

3.4 ALIGNMENT

- A. Align pump and motor shafts and piping connections after setting on foundation, grout has been set and foundation bolts have been tightened, and piping connections have been made. Alignment of pump and motor shaft shall be completed by a factory authorized representative using the reverse dial indicator or laser alignment method to within a maximum deviation of 0.02 mil/inch of dial indicator separation at each dial indicator.
- B. Comply with pump and coupling manufacturers' written instructions.
- C. Adjust pump and motor shafts for angular and offset alignment by methods specified in HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation; HI 2.1-2.5, "Vertical Pumps for Nomenclature, Definitions, Application and Operation."
- D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.5 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.

- C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.
- D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
- E. Install triple-duty valve on discharge side of pumps.
- F. Install Y-type strainer or suction diffuser and shutoff valve on suction side of pumps.
- G. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.
- H. Install pressure gages on pump suction and discharge, at integral pressure-gage tapping, or install single gage with multiple input selector valve.
- I. Install check valve and gate or ball valve on each condensate pump unit discharge.
- J. Install electrical connections for power, controls, and devices.
- K. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- L. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.6 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Check piping connections for tightness.
 - 3. Clean strainers on suction piping.
 - 4. Perform the following startup checks for each pump before starting:
 - a. Verify bearing lubrication.
 - b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
 - c. Verify that pump is rotating in the correct direction.
 - 5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
 - 6. Start motor.
 - 7. Open discharge valve slowly.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps. Refer to Division 01 Section "Demonstration and Training."

END OF DOCUMENT 23 2123

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 121505 Hydronic Pumps Section 23 2123 - 9

SECTION 23 2213 POLYPROPYLENE HEATING AND COOLING PIPING

PART 1 GENERAL

- **1.01** RELATED DOCUMENTS
 - A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
 - B. "Reference Section 01 8113 "LEED Requirements" for additional project information and criteria related to LEED and project sustainability requirements.
- 1.02 SUMMARY
 - A. This Section includes pipe and fitting materials, joining methods and specialty items for the following:
 - 1. Temporary PCA Hot-water heating piping.
 - 2. Temporary PCA Chilled Water piping.

1.03 RELATED SECTIONS

- 1. Section 01 4600 Seismic Design Requirements for Nonstructural Systems
- 2. Division 21 "Fire-Suppression." for insulation
- 3. Division 22 "Plumbing." for insulation
- 4. Division 23 "Heating, Ventilating, And Air-Conditioning (HVAC)" for duct liners.

1.04 REFERENCE DOCUMENTS

- A. ASTM F 2389-07 Standard Specification for Pressure-rated Polypropylene (PP) Piping Systems.
- 1.05 DEFINITIONS
 - A. Definitions shall be in accordance with local mechanical codes and ASTM F 2389.
- 1.06 SUBMITTALS
 - A. Material list naming each product to be used identified by manufacturer and product number, in accordance with Port standards.
- **1.07** QUALITY ASSURANCE
 - A. Material shall be certified by NSF International as complying with NSF 14, and ASTM F 2389 or CSA B137.11.
 - B. Material shall comply with manufacturer's specifications.
 - C. Special Engineered products shall be certified by NSF International as complying with NSF 14.

PART 2 PRODUCTS

- 2.01 PIPE AND PIPING PRODUCTS
 - A. Pipe shall be manufactured from a PP-R resin (Fusiolen) meeting the short-term properties and long-term strength requirements of ASTM F 2389 or CSA B137.11. The pipe shall contain no rework or recycled materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. All pipe shall be made in an extrusion process. Hydronic hot water and heating piping shall contain a fiber layer (faser) to restrict thermal expansion. All pipe shall comply with the rated pressure requirements of ASTM F 2389 or CSA B137.11. All pipe shall be certified by NSF International as complying with NSF 14, and ASTM F 2389 or CSA B137.11.

JFL - THS 5 ACRE LAND LEASE	SITE	Project No. 121505
Procurement Package	Polypropylene Heatir	ng And Cooling Piping
07/21/2023	TLC Engineering Solutions	Section 23 2213 - 1

B. Basis of design shall be Blue Pipe® MF®, available from Aquatherm, NA. Piping specifications and ordering information are available at <u>www.aquatherm.com</u>. Acceptable alternate manufacturers are Aquatechnik or Vesbo.

2.02 FITTINGS

- A. Fittings shall be manufactured from a PP-R resin (Fusiolen) meeting the short-term properties and long-term strength requirements of ASTM F 2389. The fittings shall contain no rework or recycled materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. All fittings shall be certified by NSF International as complying with NSF 14, and ASTM F 2389 or CSA B137.11.
- B. Basis of design fittings shall be Aquatherm® Blue Pipe® or equal available from Aquatherm, NA. Fittings specifications and ordering information are available at <u>www.aquatherm.com</u>. Acceptable alternate manufacturers are Aquatechnik or Vesbo.

2.03 WARRANTY

- A. Manufacturer shall warrant pipe and fittings for 10 years to be free of defects in materials or manufacturing. Retain one of four mastic paragraphs below. Product attributes in first paragraph are based on Foster; there are variations among manufacturers.
- B. Manufacturer warranty shall cover labor and material costs of repairing and/or replacing defective materials and repairing any incidental damage caused by failure of the piping system due to defects in materials or manufacturing.
- C. Manufacturer warranty shall be in effect only upon submission by the contractor to the manufacturer valid pressure/leak test documentation indicating that the system was tested and passed the manufacturer's pressure/leak test.
- 2.04 VALVES
 - A. Valves shall be manufactured in accordance with the manufacturer's specifications and shall comply with the performance requirements of ASTM F 2389 or CSA B137.11. The valves shall contain no rework or recycled thermoplastic materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material.
 - Basis of design valves shall be Aquatherm® or equal available from Aquatherm, NA.
 Valve specifications and ordering information are available at <u>www.aquatherm.com</u>.
 Acceptable alternate manufacturers are Webstone or Red White. Valves and piping must be procured from same manufacturer.
- 2.05 SMOKE AND FIRE RATINGS
 - A. Where indicated on the drawings that a Plenum-rated Piping System is needed, the pipe shall be wrapped and/or insulated with standard pipe insulation, field installed. The pipe wrap or insulation shall meet the requirements of CAN/ULC-S102.2-03 or ASTM E84. The system shall have a Flame Spread Classification of less than 25 and Smoke Development rating of less than 50.

2.06 UV PROTECTION

- A. Where indicated on the drawings that the pipe will be exposed to direct UV light for more than 30 days, it shall be provided with a Factory applied, UV-resistant coating or alternative UV protection.
- 2.07 THERMAL AND VAPOR BARRIER
 - A. Insulation materials furnished and installed hereunder should meet the minimum thickness requirements of American Society of Heating, Refrigeration, and Air Conditioning Engineers ASHRAE 90.1 (current edition), "Energy Efficient Design of New Buildings."

JFL - THS 5 ACRE LAND LEASE	SITE	Project No. 121505
Procurement Package	Polypropyler	ne Heating And Cooling Piping
07/21/2023	TLC Engineering Solutions	Section 23 2213 - 2

However, if other factors such as condensation control or personnel protection are to be considered, the selection of the thickness of insulation should satisfy the controlling factor.

- B. Where standard pipe insulation is indicated on the drawings or in these specifications, the contractor shall provide a thermal (radiant, conductive, and convective) and vapor barrier insulation. The insulation products shall be provided as indicated on the drawings or elsewhere in these specifications. The standard pipe insulation shall be UV resistant, CFC-free, non-porous, non-fibrous, and resist mold growth.
 - 1. For indoor systems operating at temperatures from 0°F (-18°C) to 200°F (93°C):
 - a. Basis of design is Owens CorningTM FiberglasTM Insulation for Aquatherm with SSL II® Positive Closure System. Approved alternate manufacturers are Johns Manville or Knauf. Product must be equivalent to basis of design.
 - 2. For systems operating below ambient (32°F (0°C) to +65°F (18°C)) temperature:
 - a. Owens CorningTM VaporWick® Pipe Insulation for Aquatherm, or equal. Approved alternate manufacturers are Johns Manville or Knauf. Product must be equivalent to basis of design.

PART 3 EXECUTION

3.01 PIPING APPLICATIONS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Installers shall be trained and certified to install the pipe according to the manufacturer's guidelines. Contact your local installed piping product representative for training.
- C. Install listed pipe materials and joining methods below in the following applications:
 - 1. Underground Piping: Polypropylene (PP-R) piping in SDR 7.4, 11, or 17.6 per manufacturer's instructions and ASTM D2774.
 - 2. Aboveground: Polypropylene (PP-R) piping in SDR 7.4, 11, or 17.6 based on the required minimum pressure rating and use temperature, in accordance with manufacturer's instructions and ASTM F2389.
- D. Installation must be accomplished with the proper tools for installing piping following manufacturer's instructions. Installation tools are available from your local representative. Tools may be purchased or rented. Tool s must be pre-approved by manufacturer for use on their product.
- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

3.02 FUSION WELDING OF JOINTS

- A. Install fittings and joints using socket-fusion, electofusion, or butt-fusion as applicable for the fitting or joint type. All fusion-weld joints shall be made in accordance with the pipe and fitting manufacturer's specifications and product standards.
- B. Fusion-weld tooling, welding machines, and electrofusion devices shall be as specified by the pipe and fittings manufacturer.
- C. Prior to joining, the pipe and fittings shall be prepared in accordance with ASTM F 2389 and the manufacturer's specifications.

D. Joint preparation, setting and alignment, fusion process, cooling times and working pressure shall be in accordance with the pipe and fitting manufacturer's

3.03 VALVE APPLICATIONS

- A. Install gate valves close to the main on each branch and riser serving 2 or more equipment connections and where indicated.
- B. Install gate or ball valves on the inlet to each equipment item and elsewhere as indicated.
- C. Install drain valve at the base of each riser, at low points of horizontal runs, and where required to drain hydronic piping system.
- D. Install swing check valve on the discharge side of each pump and elsewhere as indicated.
- E. Install ball valves in each hot-water circulating loop and the discharge side of each pump.
- F. Fire stopping shall be provided to both be compatible with the PP-R Piping and meet the requirements of ASTM E 814 or ULC S115, "Fire Tests of Through-Penetration Firestops". Pipe insulations or fire resistive coating shall be removed where the pipe passes through a fire stop and, if required by the firestop manufacturer, for 3 inches beyond the firestop outside of the fire barrier.
- G. When installed in systems with pumps in excess of 7.5 HP, piping shall be protected from excessive heat generated by operating the pump at shut-off conditions. Where the possibility exists that the pump will operate with no flow, the protection method shall be a temperature relief valve or comparable level of protection, set to a maximum temperature of 185°F.
- H. If heat tracing or freeze protection is specified for the piping, it should be installed on the pipe interior or exterior. It must be suitable for use with plastic piping and be self-regulating to ensure that the surface temperature of the pipe and fittings will not exceed 70°C (158°F).

3.04 HANGER AND SUPPORT INSTALLATION

2.

- A. Comply with requirements for seismic-restraint devices in Section 01 4600 "Seismic Design Requirements for Nonstructural Systems".
- B. Provide hangers and supports based on manufactures requirements.
 - 1. Vertical Piping: MSS Type 8 or 42, clamps.
 - Individual, Straight, Horizontal Piping Runs:
 - a. Adjustable, steel clevis hangers.
 - b. Clamps on strut trapeze.
 - c. Clamps on strut attached to the structure.
 - d. Clamps attached directly to the structure.
 - 3. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support vertical piping and tubing at base and at each floor. For piping 2" (63mm) or smaller, install mid-story guides.
- D. Install hangers and supports at intervals specified as recommended by pipe manufacturer.
- E. For uninsulated hot water piping, provide clamps and supports that are felt or rubber/vinyl coated or lined.
- F. For uninsulated cold water piping supports and clamps may be bare metal. Ensure that the clamp or support does not have sharp edges that may scrape or gouge the piping.
- G. Use care when installing riser clamps to not over tighten the clamps to cause indentation of the pipe or insulation.

3.05 EXPANSION AND CONTRACTION APPLICATIONS

- A. Provide expansion and contraction controls, guides and anchors to take into account the expansion and contraction of the pipe. Provide expansion loops or offsets as required and as indicated in the installed/purchased pipe manufacturer's literature.
 - 1. Aquatherm MF (faser) piping can absorb most of their own expansion stresses, this can cause the pipe to bow or bend.
 - 2. Install anchor points at least every 120 feet for BOD pipe. Consult manufacture for alternate manufacturers.
 - 3. Install expansion loop or offset between each anchor point. Expansion device must be able to absorb all of the stresses between the two anchor points. Refer to manufacturer's published instructions, formulas and calculations at www.aquatherm.com.
 - 4. Non-MF pipes used for hot applications shall have expansion controls every 30 feet of straight runs.
 - 5. Vertical risers of MF piping shall be anchored at each floor.
 - 6. Provide anchor point at branch take-off in vertical riser of MF piping.

3.06 PRESSURE TESTING

- A. While still accessible all piping shall be pressure/leak tested to the manufacturer's standards. Tests shall be carried out using water, compressed air or a mixture of the two. The test pressure shall be as indicated in the pressure leak testing procedures required by the manufacturer. Any leaks detected shall be repaired at the contractor's expense by removing the leaking part and replacing with new parts welded per the pipe manufacturer's guidelines. See www.aquatherm.com for additional details and forms.
- 3.07 INSPECTING AND CLEANING
 - A. The pipes should be flushed with cold water after finishing the installation. Inspect and test piping systems following procedures of authorities having jurisdiction and as specified by the piping system manufacturer.

PART 4 MEASUREMENT AND PAYMENT

- 4.01 GENERAL
 - A. For incidental work: No separate measurement or payment will be made for the work required by this section. The cost for this portion of the Work will be considered incidental to, and included in: (i) the established hourly rates for any portion of the Work falling within the scope of Preconstruction Services, (ii) the Fixed amount for Specified General Conditions or Percent Fee for any portion of the Work falling within the scope of Construction Services and performed by the GC/CM, and (iii) the Total for Subcontract Costs for any portion of the Work falling within the scope the Construction Services and performed by any Subcontractor (of any tier) or Supplier.
 - B. For work separately paid: The cost for the portion of the Work required by this section shall: (i) to the extent performed by the GC/CM and not specifically identified as Negotiated Support Services, be incidental to, and included within, the Fixed Amount for Specified General Conditions or Percent Fee, (ii) to the extent performed by the GC/CM and specifically identified as Negotiated Support Services, be paid as authorized by the Port when the NSS item was approved, and (iii) to the extent performed by any Subcontractor (of any tier) or Supplier, be paid at the contract price included within the Total for Subcontract Costs. Such payment shall be full compensation for providing this Work.

END OF SECTION

JFL - THS 5 ACRE LAND LEASE	SITE	Project No. 121505
Procurement Package	Polyprop	oylene Heating And Cooling Piping
07/21/2023	TLC Engineering Solutions	Section 23 2213 - 5

SECTION 23 2216 STEAM AND CONDENSATE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes the following piping specialties for LP and HP steam and condensate piping:
 - 1. Strainers.
 - 2. Flash tanks.
 - 3. Safety valves.
 - 4. Pressure-reducing valves.
 - 5. Steam traps.
 - 6. Thermostatic air vents and vacuum breakers.
 - 7. Steam and condensate meters.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Pressure-reducing and safety valve.
 - 2. Steam trap.
 - 3. Air vent and vacuum breaker.
 - 4. Flash tank.
 - 5. Meter.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For valves, safety valves, pressure-reducing valves, steam traps, air vents, vacuum breakers, and meters to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Pipe Welding: Qualify procedures and operators according to the following:
 - 1. ASME Compliance: Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp flash tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures unless otherwise indicated:
 - 1. HP Steam Piping: 110 psig.
 - 2. LP Steam Piping: 30 psig.
 - 3. Condensate Piping: 15 psig at 250 deg F.
 - 4. Makeup-Water Piping: 80 psig at 150 deg F.
 - 5. Blowdown-Drain Piping: Equal to pressure of the piping system to which it is attached.
 - 6. Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached.
 - 7. Safety-Valve-Inlet and -Outlet Piping: Equal to pressure of the piping system to which it is attached.

2.2 VALVES

- A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Section 23 0523 "General-Duty Valves for HVAC Piping."
- B. Stop-Check Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A.Y. McDonald Mfg. Co.
 - b. Cincinnati Valve Company.
 - c. Crane; Crane Energy Flow Solutions.
 - d. Apollo Valves
 - 2. Body and Bonnet: Malleable iron.
 - 3. End Connections: Flanged.
 - 4. Disc: Cylindrical with removable liner and machined seat.
 - 5. Stem: Brass alloy.
 - 6. Operator: Outside screw and yoke with cast-iron handwheel.
 - 7. Packing: Polytetrafluoroethylene-impregnated packing with two-piece packing gland assembly.
 - 8. Pressure Class: 250.

2.3 STRAINERS

- A. Y-Pattern Strainers:
 - 1. Body: ASTM A 126, Class B cast iron, with bolted cover and bottom drain connection.
 - 2. End Connections: Threaded ends for strainers NPS 2 and smaller; flanged ends for strainers NPS 2-1/2 and larger.
 - 3. Strainer Screen: Stainless-steel, [20] [40] [60]-mesh strainer, or perforated stainless-steel basket.
 - 4. Tapped blowoff plug.
 - 5. CWP Rating: 250-psig working steam pressure.

- B. Basket Strainers:
 - 1. Body: ASTM A 126, Class B cast iron, with bolted cover and bottom drain connection.
 - 2. End Connections: Threaded ends for strainers NPS 2 and smaller; flanged ends for strainers NPS 2-1/2 and larger.
 - 3. Strainer Screen: Stainless-steel, [20] <Insert number> mesh strainer, and perforated stainless-steel basket with 50 percent free area.
 - 4. CWP Rating: 250-psig working steam pressure.

2.4 SAFETY VALVES

- A. Bronze or Brass Safety Valves: ASME labeled.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong International, Inc.
 - b. Spirax Sarco, Inc.
 - c. Watts Regulator Co.
 - 2. Disc Material: Forged copper alloy.
 - 3. End Connections: Threaded inlet and outlet.
 - 4. Spring: Fully enclosed steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
 - 5. Pressure Class: 250.
 - 6. Drip-Pan Elbow: Cast iron and having threaded inlet and outlet with threads complying with ASME B1.20.1.
 - 7. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.
- B. Cast-Iron Safety Valves: ASME labeled.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong International, Inc.
 - b. Spirax Sarco, Inc.
 - c. Watts Regulator Co.
 - 2. Disc Material: Forged copper alloy with bronze nozzle.
 - 3. End Connections: Raised-face flanged inlet and threaded or flanged outlet connections.
 - 4. Spring: Fully enclosed cadmium-plated steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
 - 5. Pressure Class: 250.
 - 6. Drip-Pan Elbow: Cast iron and having threaded inlet, outlet, and drain, with threads complying with ASME B1.20.1.
 - 7. Exhaust Head: Cast iron and having threaded inlet and drain, with threads complying with ASME B1.20.1.
 - 8. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.

2.5 PRESSURE-REDUCING VALVES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Armstrong International, Inc.
 - 2. Hoffman Specialty.
 - 3. Spirax Sarco, Inc.
- B. ASME labeled.
- C. Size, Capacity, and Pressure Rating: Factory set for inlet and outlet pressures indicated.
- D. Description: Pilot-actuated, diaphragm type, with adjustable pressure range and positive shutoff.
- E. Body: Cast iron.
- F. End Connections: Threaded connections for valves NPS 2 and smaller and flanged connections for valves NPS 2-1/2 and larger.
- G. Trim: Hardened stainless steel.
- H. Head and Seat: Replaceable, main head stem guide fitted with flushing and pressure-arresting device cover over pilot diaphragm.
- I. Gaskets: Non-asbestos materials.

2.6 STEAM TRAPS

- A. Thermostatic Traps:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong International, Inc.
 - b. Hoffman Specialty.
 - c. Spirax Sarco, Inc.
 - 2. Body: Bronze angle-pattern body with integral union tailpiece and screw-in cap.
 - 3. Trap Type: Balanced-pressure.
 - 4. Bellows: Stainless steel or monel.
 - 5. Head and Seat: Replaceable, hardened stainless steel.
 - 6. Pressure Class: 125.
- B. Thermodynamic Traps:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong International, Inc.
 - b. Hoffman Specialty.
 - c. Spirax Sarco, Inc.
 - 2. Body: Stainless steel with screw-in cap.

- 3. End Connections: Threaded.
- 4. Disc and Seat: Stainless steel.
- 5. Maximum Operating Pressure: 600 psig.
- C. Float and Thermostatic Traps:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong International, Inc.
 - b. Hoffman Specialty.
 - c. Spirax Sarco, Inc.
 - 2. Body and Bolted Cap: ASTM A 126, cast iron.
 - 3. End Connections: Threaded.
 - 4. Float Mechanism: Replaceable, stainless steel.
 - 5. Head and Seat: Hardened stainless steel.
 - 6. Trap Type: Balanced pressure.
 - 7. Thermostatic Bellows: Stainless steel or monel.
 - 8. Thermostatic air vent capable of withstanding 45 deg F of superheat and resisting water hammer without sustaining damage.
 - 9. Vacuum Breaker: Thermostatic with phosphor bronze bellows, and stainless-steel cage, valve, and seat.
 - 10. Maximum Operating Pressure: 125 psig.
- D. Inverted Bucket Traps:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong International, Inc.
 - b. Hoffman Specialty.
 - c. Spirax Sarco, Inc.
 - 2. Body and Cap: Cast iron.
 - 3. End Connections: Threaded.
 - 4. Head and Seat: Stainless steel.
 - 5. Valve Retainer, Lever, and Guide Pin Assembly: Stainless steel.
 - 6. Bucket: Brass or stainless steel.
 - 7. Strainer: Integral stainless-steel inlet strainer within the trap body.
 - 8. Air Vent: Stainless-steel thermostatic vent.
 - 9. Pressure Rating: 250 psig.

2.7 THERMOSTATIC AIR VENTS AND VACUUM BREAKERS

- A. Thermostatic Air Vents:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong International, Inc.
 - b. Hoffman Specialty.
 - c. Spirax Sarco, Inc.
 - 2. Body: Cast iron, bronze, or stainless steel.
 - 3. End Connections: Threaded.
 - 4. Float, Valve, and Seat: Stainless steel.

- 5. Thermostatic Element: Phosphor bronze bellows in a stainless-steel cage.
- 6. Pressure Rating: 125 psig or 300 psig.
- 7. Maximum Temperature Rating: 350 deg F.
- B. Vacuum Breakers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong International, Inc.
 - b. Hoffman Specialty.
 - c. Spirax Sarco, Inc.
 - 2. Body: Cast iron, bronze, or stainless steel.
 - 3. End Connections: Threaded.
 - 4. Sealing Ball, Retainer, Spring, and Screen: Stainless steel.
 - 5. O-Ring Seal: EPR.
 - 6. Pressure Rating: 125 psig or 300 psig.
 - 7. Maximum Temperature Rating: 350 deg F.

2.8 FLEXIBLE CONNECTORS

- A. Stainless-Steel Bellows, Flexible Connectors:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Duraflex, Inc.
 - b. Flexicraft Industries.
 - c. Hyspan Precision Products, Inc.
 - d. Mason Industries, Inc.
 - e. Metraflex Company (The).
 - 2. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforced, protective jacket.
 - 3. End Connections: Threaded or flanged to match equipment connected.
 - 4. Performance: Capable of 3/4-inch misalignment.
 - 5. CWP Rating: 150 psig.
 - 6. Maximum Operating Temperature: 250 deg F.

2.9 STEAM METERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. EMCO Flow Systems.
 - 2. ISTEC Corp.
 - 3. Preso Meters.
 - 4. Spirax Sarco, Inc.
- B. Meters shall have a microprocessor to display totalizer flow, flow rate, temperature, pressure, time, and date; alarms for high and low flow rate and temperature.
 - 1. Computer shall have 4- to 20-mA or 2- to 10-V output for temperature, pressure, and contact closure for flow increments.

- 2. Independent timers to store four peak flow rates and total flow.
- 3. Interface compatible with central workstation described in Section 23 0900 "Instrumentation and Control for HVAC."
- 4. Microprocessor Enclosure: NEMA 250, Type 4.
- C. Sensor: Venturi, of stainless-steel construction, for insertion in pipeline between flanges. At least 10:1 turndown with plus or minus 1 percent accuracy over full-flow range.
- D. Sensor: Vortex type with stainless-steel wetted parts and flange connections; and with a piezoelectric sensor removable and serviceable without shutting down the process. At least 10:1 turndown with plus or minus 1 percent accuracy over full-flow range.
- E. Sensor: Spring-loaded, variable-area flowmeter type; density compensated with stainless-steel wetted parts and flange connections. At least 10:1 turndown with plus or minus 2 percent accuracy over full-flow range.

2.10 CONDENSATE METERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Central Station Steam Co.
 - 2. Lincoln Meter Company.
- B. Body: Cast iron, bronze, or brass.
- C. Turbine: Copper, brass, or stainless steel.
- D. Connections: Threaded for NPS 2 and smaller and flanged for NPS 2-1/2.
- E. Totalizer: Meters shall have a microprocessor to display flow, flow rate, time, and date; alarms for high and low flow rate, pressure, and temperature.
 - 1. Computer shall have 4- to 20-mA or 2- to 10-V output for temperature, pressure, and contact closure for flow increments.
 - 2. Independent timers to store four peak flow rates and total flow.
 - 3. Interface compatible with central workstation specified in Section 23 0900 "Instrumentation and Control for HVAC."
 - 4. Microprocessor Enclosure: NEMA 250, Type 4.
- F. Pressure Rating: Atmospheric.
- G. Maximum Temperature Rating: 250 deg F.

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

- A. Install shutoff duty valves at branch connections to steam supply mains, at steam supply connections to equipment, and at the outlet of steam traps.
- B. Install safety valves on pressure-reducing stations and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to nearest floor

drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

3.2 PIPING INSTALLATION

- A. Install piping to permit valve servicing.
- B. Install drains, consisting of a tee fitting, NPS 3/4 full port-ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- C. Install valves according to Section 23 0523 "General-Duty Valves for HVAC Piping."
- D. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- E. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- F. Install shutoff valve immediately upstream of each dielectric fitting.
- G. Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install NPS 3/4 nipple and full port ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.
- H. Flash Tank:
 - 1. Pitch condensate piping down toward flash tank.
 - 2. If more than one condensate pipe discharges into flash tank, install a check valve in each line.
 - 3. Install thermostatic air vent at tank top.
 - 4. Install safety valve at tank top.
 - 5. Install full-port ball valve, and swing check valve on condensate outlet.
 - 6. Install inverted bucket or float and thermostatic trap at low-pressure condensate outlet, sized for three times the calculated heat load.
 - 7. Install pressure gage on low-pressure steam outlet according to Section 23 0519 "Meters and Gages for HVAC Piping."

3.3 STEAM-TRAP INSTALLATION

- A. Install steam traps in accessible locations as close as possible to connected equipment.
- B. Install full-port ball valve, strainer, and union upstream from trap; install union, check valve, and full-port ball valve downstream from trap unless otherwise indicated.

3.4 PRESSURE-REDUCING VALVE INSTALLATION

- A. Install pressure-reducing valves in accessible location for maintenance and inspection.
- B. Install bypass piping around pressure-reducing valves, with globe valve equal in size to area of pressure-reducing valve seat ring, unless otherwise indicated.
- C. Install gate valves on both sides of pressure-reducing valves.

- D. Install unions or flanges on both sides of pressure-reducing valves having threaded- or flangedend connections, respectively.
- E. Install pressure gages on low-pressure side of pressure-reducing valves after the bypass connection according to Section 23 0519 "Meters and Gages for HVAC Piping."
- F. Install strainers upstream for pressure-reducing valve.
- G. Install safety valve downstream from pressure-reducing valve station.

3.5 STEAM OR CONDENSATE METER INSTALLATION

- A. Install meters with lengths of straight pipe upstream and downstream according to steam meter manufacturer's written instructions.
- B. Provide data acquisition wiring. See Section 23 0900 "Instrumentation and Control for HVAC."

3.6 SAFETY VALVE INSTALLATION

- A. Install safety valves according to [ASME B31.1, "Power Piping."] [ASME B31.9, "Building Services Piping."] [ASME B31.1, "Power Piping"; and ASME B31.9, "Building Services Piping."]
- B. Pipe safety-valve discharge without valves to atmosphere outside the building.
- C. Install drip-pan elbow fitting adjacent to safety valve and pipe drain connection to nearest floor drain.
- D. Install exhaust head with drain to waste, on vents equal to or larger than NPS 2-1/2.

3.7 TERMINAL EQUIPMENT CONNECTIONS

- A. Install traps and control valves in accessible locations close to connected equipment.
- B. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.
- C. Install vacuum breakers downstream from control valve, close to coil inlet connection.

END OF SECTION 23 2216

SECTION 23 2223 STEAM CONDENSATE PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes steam condensate pumps.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated. Indicate pump's operating point on curves. Include receiver capacity and material.
- B. Shop Drawings: For each pump.
 - 1. Show pump layout and connections.
 - 2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
 - 3. Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 SINGLE-STAGE, CENTRIFUGAL PUMPS WITH FLOOR-MOUNTED RECEIVER

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Armstrong Fluid Handling; Div. of Armstrong International, Inc.
 - 2. ITT Corporation; Domestic Pump Division.
 - 3. Spirax-Sarco Inc.
- B. Description: Factory-fabricated, packaged, electric-driven pumps; with receiver, pumps, controls, and accessories suitable for operation with steam condensate.
 - 1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. ASME Compliance: Fabricate and label steam condensate receivers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

- C. Configuration: Duplex floor-mounted pump with receiver and float switches; rated to pump 200 deg F steam condensate.
- D. Receiver:
 - 1. Floor mounted.
 - 2. Welded steel.
 - 3. Externally adjustable float switches.
 - 4. Flanges for pump mounting.
 - 5. Water-level gage and dial thermometer.
 - 6. Pressure gage at pump discharge.
 - 7. Bronze fitting isolation valve between pump and receiver.
 - 8. Lifting eyebolts.
 - 9. Inlet vent and an overflow.
 - 10. Cast-iron inlet strainer with vertical self-cleaning bronze screen and large dirt pocket.
 - 11. By-pass line with isolation valves around pump assembly to drain.
- E. Pumps:
 - 1. Centrifugal, close coupled vertical design.
 - 2. Permanently aligned.
 - 3. Bronze fitted.
 - 4. Replaceable bronze case ring.
 - 5. Mechanical seals rated at 250 deg F.
 - 6. Mounted on receiver flange.
- F. Motor:
 - Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 23 0513 "Common Motor Requirements for HVAC Equipment."
 - 2. Enclosure: Open, dripproof; totally enclosed, fan cooled.
 - 3. Enclosure Materials: Rolled steel.
 - 4. Motor Bearings: Permanently lubricated ball bearings.
- G. Control Panel:
 - 1. Factory wired between pumps and float switches, for single external electrical connection.
 - 2. Provide fused, control-power transformer if voltage exceeds 230 V ac.
 - 3. NEMA 250, Type 3 enclosure with hinged door and grounding lug, mounted on pump.
 - 4. Motor controller for each pump.
 - 5. Electrical pump alternator to operate pumps in lead-lag sequence and allow both pumps to operate on receiver high level.
 - 6. Manual lead-lag control to override electrical pump alternator and manually select the lead pump.
 - 7. Momentary-contact "TEST" push button on cover for each pump.
 - 8. Numbered terminal strip.
 - 9. Disconnect switch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 121505 Steam Condensate Pumps Section 23 2223 - 2

- B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install pumps according to HI 1.1-1.2, HI 1.3, and HI 1.4.
- B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.
- C. Support pumps and piping separately so piping is not supported by pumps.
- D. Install thermometers and pressure gages.
- E. Equipment Mounting:
 - 1. Install pumps on cast-in-place concrete equipment base(s).
 - 2. Comply with requirements for vibration isolation and seismic control devices specified in Section 23 0548 "Vibration and Seismic Controls for HVAC."
 - 3. Comply with requirements for vibration isolation devices specified in Section 23 0548.13 "Vibration Controls for HVAC."

3.3 CONNECTIONS

- A. Comply with requirements for piping specified in Section 23 2213 "Steam and Condensate Heating Piping" and Section 23 2216 "Steam and Condensate Piping Specialties."
- B. Where installing piping adjacent to machine, allow space for service and maintenance.
- C. Install compressed-air supply for pressure-powered pumps as required in Section 22 1513 "General-Service Compressed-Air Piping."
- D. Install a globe and check valve and pressure gage before inlet of each pump and a gate and check valve at pump outlet.
- E. Pipe drain to nearest floor drain for overflow and drain piping connections.
- F. Install full-size vent piping to outdoors, terminating in 180-degree elbow at point above highest steam system connection or as indicated.
- G. Ground equipment according to Section 26 0526 "Grounding and Bonding for Electrical Systems."
- H. Connect wiring according to Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables."
- I. Provide full-size by-pass with valve for pump failure.

3.4 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.

- 2. Clean strainers.
- 3. Set steam condensate pump controls.
- 4. Set pump controls for automatic start, stop, and alarm operation.
- 5. Perform the following preventive maintenance operations and checks before starting:
 - a. Set float switches to operate at proper levels.
 - b. Set throttling valves on pump discharge for specified flow.
 - c. Check motors for proper rotation.
 - d. Test pump controls and demonstrate compliance with requirements.
 - e. Replace damaged or malfunctioning pump controls and equipment.
 - f. Verify that pump controls are correct for required application.
- 6. Start steam condensate pumps according to manufacturer's written startup instructions.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain steam condensate pumps.

END OF SECTION 23 2223

SECTION 23 3113 METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Single-wall rectangular ducts and fittings.
 - 2. Double-wall rectangular ducts and fittings.
 - 3. Single-wall round and flat-oval ducts and fittings.
 - 4. Double-wall round and flat-oval ducts and fittings.
 - 5. Sheet metal materials.
 - 6. Sealants and gaskets.
 - 7. Hangers and supports.
 - 8. Duct leakage testing.
 - 9. Duct cleaning.

1.3 **PERFORMANCE REQUIREMENTS**

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible" and performance requirements and design criteria indicated.
 - 1. Static-Pressure Classes:
 - a. Supply Ducts (Upstream from Air Terminal Units): 4 inch wg.
 - b. Supply Ducts (Downstream from Air Terminal Units): 1-inch wg.
 - c. Return Ducts (Negative Pressure): 3 inch wg.
 - d. Exhaust Ducts (Negative Pressure): 2 inch wg.
 - e. Return Air Duct: 3 cfm/100 sq. ft. at 6-inch wg.
 - f. Exhaust Air Duct: 6 cfm/100 sq. ft. at 3-inch wg.
 - g. Flexible Duct: 6 cfm/100 sq. ft. at 1-inch wg.
- B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards Metal and Flexible".

1.4 SUBMITTALS

- A. Product Data: For each type of the following products:
 - 1. Adhesives.
 - 2. Sealants and gaskets.
- B. Shop Drawings:

- 1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
- 2. Factory- and shop-fabricated ducts and fittings.
- 3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
- 4. Elevation of top of ducts.
- 5. Dimensions of main duct runs from building grid lines.
- 6. Fittings.
- 7. Reinforcement and spacing.
- 8. Seam and joint construction.
- 9. Penetrations through fire-rated and other partitions.
- 10. Equipment installation based on equipment being used on Project.
- 11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
- 12. Hangers and supports, including methods for duct and building attachment and vibration isolation.
- C. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
 - 2. Suspended ceiling components.
 - 3. Structural members to which duct will be attached.
 - 4. Size and location of initial access modules for acoustical tile.
 - 5. Penetrations of smoke barriers and fire-rated construction.
 - 6. Items penetrating finished ceiling including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Perimeter moldings.
- D. Welding certificates.
- E. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Figure 1-5, "Longitudinal Seams Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards Metal and Flexible." Punch-button snap lock longitudinal seams are not acceptable.
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards Metal and Flexible."

2.2 DOUBLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. McGill AirFlow LLC.
 - 2. Sheet Metal Connectors, Inc.
- B. Rectangular Ducts: Fabricate ducts with indicated dimensions for the inner duct.
- C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- D. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- E. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Figure 1-5, "Longitudinal Seams Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards Metal and Flexible." Punch-button snap lock longitudinal seams are not acceptable.
- F. Inner Duct Liner is prohibited.
- G. Inner Duct: Minimum 0.028-inch solid sheet steel.
- Formed-on Transverse Joints (Flanges): Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Traverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- I. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams -Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct

Project No. 121505 Metal Ducts Section 23 3113 - 3 Construction Standards - Metal and Flexible." Punch-button snap lock longitudinal seams are not acceptable.

2.3 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Lindab Inc.
 - b. McGill AirFlow LLC.
 - c. SEMCO Incorporated.
 - d. Sheet Metal Connectors, Inc.
 - e. Spiral Manufacturing Co., Inc.
- B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter (diameter of the round sides connecting the flat portions of the duct).
- C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, ductsupport intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
- D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." Punch-button snap lock longitudinal seams are not acceptable.
 - 1. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with buttwelded longitudinal seams.
- E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- F. The use of "snap lock" ductwork is prohibited.

2.4 DOUBLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Lindab Inc.
 - 2. McGill AirFlow LLC.
 - 3. SEMCO Incorporated.

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

Project No. 121505 Metal Ducts Section 23 3113 - 4

- 4. Sheet Metal Connectors, Inc.
- B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter (diameter of the round sides connecting the flat portions of the duct) of the inner duct.
- C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.
 - Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints -Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - a. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
- D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." snap lock longitudinal seams are not acceptable.
 - a. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with buttwelded longitudinal seams.
- E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- F. Inner Duct: Minimum 0.028-inch solid sheet steel.
- G. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
 - 1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 - 2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
 - 3. Coat insulation with antimicrobial coating.
 - 4. Cover insulation with polyester film complying with UL 181, Class 1.

2.5 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

- 1. Galvanized Coating Designation: G90.
- 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.
- D. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.
- E. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
- F. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
 - 1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches. Tie rods shall be attached to the ducts in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".

2.6 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Two-Part Tape Sealing System is not acceptable.
- C. Water-Based Joint and Seam Sealant:
 - 1. Application Method: Brush on.
 - 2. Solids Content: Minimum 65 percent.
 - 3. Shore A Hardness: Minimum 20.
 - 4. Water resistant.
 - 5. Mold and mildew resistant.
 - 6. VOC: Maximum 75 g/L (less water).
 - 7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 - 8. Service: Indoor or outdoor.
 - 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- D. Solvent-Based Joint and Seam Sealant:
 - 1. Application Method: Brush on.
 - 2. Base: Synthetic rubber resin.
 - 3. Solvent: Toluene and heptane.
 - 4. Solids Content: Minimum 60 percent.
 - 5. Shore A Hardness: Minimum 60.
 - 6. Water resistant.

TLC Engineering Solutions

- 7. Mold and mildew resistant.
- 8. VOC: Maximum 395 g/L.
- 9. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
- 10. Service: Indoor or outdoor.
- 11. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- E. Flanged Joint Sealant: Comply with ASTM C 920.
 - 1. General: Single-component, acid-curing, silicone, elastomeric.
 - 2. Type: S.
 - 3. Grade: NS.
 - 4. Class: 25.
 - 5. Use: O.
- F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- G. Round Duct Joint O-Ring Seals:
 - 1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for static-pressure class, positive or negative.
 - 2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
 - 3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.7 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards -Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
- F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- H. Trapeze and Riser Supports:
 - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 - 2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.

3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards Metal and Flexible" unless otherwise indicated.
- C. Install round and flat-oval ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.
- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."

3.2 SEAM AND JOINT SEALING

A. Seal duct seams and joints for duct static-pressure and leakage classes specified in "Performance Requirements" Article, according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 1-2, "Standard Duct Sealing Requirements," unless otherwise indicated.

- 1. For static-pressure classes 1- and 1/2-inch wg, comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Seal Class B, except as follows:
 - a. Ducts that are located directly in zones they serve.
 - b. Ducts that have short runs from volume-control boxes to diffusers.
- B. Seal Classes: Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Table 1-2, "Standard Duct Sealing Requirements."
 - a. For static-pressure classes 2-inch wg and above, comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Seal Class A.

3.3 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Chapter 4, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Where practical, install concrete inserts before placing concrete.
 - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
 - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
 - 5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.4 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.5 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanizedsteel primer. Paint materials and application requirements are specified in Division 09 Sections 09123.

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Leakage Tests:
 - 1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual."
 - 2. Test the following systems:
 - a. Supply air.
 - b. Return air.
 - c. Exhaust air.
 - 3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
 - 4. Test for leaks before insulation application and prior to completion of rated shaft wall construction.
 - 5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
- C. Duct System Cleanliness Tests:
 - 1. Visually inspect duct system to ensure that no visible contaminants are present.
 - Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
 - a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.
- D. Duct system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.7 DUCT CLEANING

- A. Clean new duct system(s) in patient care areas before testing, adjusting, and balancing.
- B. Use service openings for entry and inspection.
 - 1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated duct.
Patch insulation as recommended by duct manufacturer. Comply with Division 23 Section "Air Duct Accessories" for access panels and doors.

- 2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
- 3. Remove and reinstall ceiling to gain access during the cleaning process.
- C. Particulate Collection and Odor Control:
 - 1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
 - 2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.
- D. Clean the following components by removing surface contaminants and deposits:
 - 1. Air outlets and inlets (registers, grilles, and diffusers).
 - 2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
 - 3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
 - 4. Coils and related components.
 - 5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
 - 6. Supply-air ducts, dampers, actuators, and turning vanes.
 - 7. Dedicated exhaust and ventilation components and makeup air systems.
- E. Mechanical Cleaning Methodology:
 - 1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
 - 2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
 - 3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
 - 4. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
 - 5. Provide drainage and cleanup for wash-down procedures.
 - 6. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.8 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel except as follows:
 - 1. Acid-Resistant (Fume-Handling) Ducts:
 - a. Type 316, stainless-steel sheet.
 - b. Exposed to View: No. 4 finish.
 - c. Concealed: No. 2D finish.
 - 2. Acid-Resistant (Fume-Handling) Ducts: PVC-coated, galvanized sheet steel with thicker coating on duct interior.
 - 3. Moist Environment Ducts: Aluminum.
- B. Intermediate Reinforcement:
 - 1. Galvanized-Steel Ducts: Galvanized steel.
 - 2. Stainless-Steel Ducts: Galvanized steel.
 - 3. Aluminum Ducts: Aluminum or galvanized sheet steel coated with zinc chromate.
- C. Double-Wall Duct Interstitial Insulation:
 - 1. Supply and Return Air Ducts, 16 Inches and Smaller in Diameter or Rectangular Equivalent: 1 inch thick.
 - 2. Supply and Return Air Ducts, 18 Inches and Larger in Diameter or Rectangular Equivalent: 1 inch thick.
- D. Elbow Configuration:
 - 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards -Metal and Flexible," Figure 2-2, "Rectangular Elbows."
 - a. Velocity 1000 fpm or Lower:
 - 1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
 - 2) Mitered Type RE 4 without vanes.
 - b. Velocity 1000 to 1500 fpm:
 - 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
 - 2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
 - Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
 - c. Velocity 1500 fpm or Higher:
 - 1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - 2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.

- Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
- 2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Figure 3-3, "Round Duct Elbows."
 - Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
 - 1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
 - 2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
 - 3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
 - b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
 - c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.
- E. Branch Configuration:
 - 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards -Metal and Flexible," Figure 2-6, "Branch Connections."
 - a. Rectangular Main to Rectangular Branch: 45-degree entry.
 - b. Rectangular Main to Round Branch: Spin in.
 - Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees." Saddle taps are permitted in existing duct.
 - a. Velocity 1000 fpm or Lower: 90-degree tap.
 - b. Velocity 1000 to 1500 fpm: Conical tap.
 - c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF DOCUMENT 23 3113

SECTION 23 3300 AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Backdraft and pressure relief dampers.
 - 2. Barometric relief dampers.
 - 3. Manual volume dampers.
 - 4. Control dampers.
 - 5. Fire dampers.
 - 6. Ceiling dampers.
 - 7. Combination fire and smoke dampers.
 - 8. Corridor dampers.
 - 9. Flange connectors.
 - 10. Turning vanes.
 - 11. Remote damper operators.
 - 12. Duct-mounted access doors.
 - 13. Flexible connectors.
 - 14. Flexible ducts.
 - 15. Duct accessory hardware.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.
- B. LEED Submittal:
 - 1. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1-2004, Section 5 "Systems and Equipment."
- C. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
 - 1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
 - a. Special fittings.
 - b. Manual volume damper installations.
 - c. Control damper installations.

- d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
- e. Retain subparagraph below if equipment includes wiring.
- f. Wiring Diagrams: For power, signal, and control wiring.
- D. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceilingmounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.
- E. Source quality-control reports.
- F. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with AMCA 500-D testing for damper rating.

1.5 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G90.
 - 2. Exposed-Surface Finish: Mill phosphatized.
- C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and exposed ducts.
- D. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- E. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.
- F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 BACKDRAFT AND PRESSURE RELIEF DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Greenheck Fan Corporation.
 - 2. Lloyd Industries, Inc.
 - 3. Nailor Industries Inc.
 - 4. Ruskin Company.
- B. Description: Gravity balanced.
- C. Maximum Air Velocity: 2000 fpm.
- D. Maximum System Pressure: 2-inch wg.
- E. Frame: 0.052-inch- thick, galvanized sheet steel, with welded corners and mounting flange.
- F. Blades: Multiple single-piece blades, center-pivoted, maximum 6-inch width, 0.050-inch-thick aluminum sheet with sealed edges.
- G. Blade Action: Parallel.
- H. Blade Seals: Vinyl foam.
- I. Blade Axles:
 - 1. Material: Stainless steel.
 - 2. Diameter: 0.20 inch.
- J. Tie Bars and Brackets: Aluminum.
- K. Return Spring: Adjustable tension.
- L. Bearings: Synthetic pivot bushings.
- M. Accessories:
 - 1. Adjustment device to permit setting for varying differential static pressure.
 - 2. Counterweights and spring-assist kits for vertical airflow installations.
 - 3. Electric actuators.
 - 4. Chain pulls.
 - 5. Screen Mounting: Front mounted in sleeve.
 - a. Sleeve Thickness: 20-gage minimum.
 - b. Sleeve Length: 6 inches minimum.
 - 6. Screen Mounting: Rear mounted.
 - 7. Screen Material: Aluminum.

- 8. Screen Type: Bird.
- 9. 90-degree stops.

2.3 BAROMETRIC RELIEF DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Greenheck Fan Corporation.
 - 2. Lloyd Industries, Inc.
 - 3. Nailor Industries Inc.
 - 4. Ruskin Company.
- B. Suitable for horizontal or vertical mounting.
- C. Maximum Air Velocity: 2000 fpm.
- D. Maximum System Pressure: 2-inch wg.
- E. Frame: 0.064-inch- thick, galvanized sheet steel with welded corners and mounting flange.
- F. Blades:
 - 1. Multiple, 0.050-inch- thick aluminum sheet.
 - 2. Maximum Width: 6 inches.
 - 3. Action: Parallel.
 - 4. Balance: Gravity.
 - 5. Eccentrically pivoted.
- G. Blade Seals: Vinyl.
- H. Blade Axles: Nonferrous metal.
- I. Tie Bars and Brackets:
 - 1. Material: Aluminum.
 - 2. Rattle free with 90-degree stop.
- J. Return Spring: Adjustable tension.
- K. Bearings: Stainless steel.
- L. Accessories:
 - 1. Flange on intake.
 - 2. Adjustment device to permit setting for varying differential static pressures.

2.4 MANUAL VOLUME DAMPERS

- A. Standard, Steel, Manual Volume Dampers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. McGill AirFlow LLC.

- b. METALAIRE, Inc.
- c. Nailor Industries Inc.
- d. Ruskin Company.
- 2. Standard leakage rating.
- 3. Suitable for horizontal or vertical applications.
- 4. Frames:
 - a. Hat-shaped, galvanized steel channels, 0.064-inch minimum thickness.
 - b. Mitered and welded corners.
 - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
- 5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Galvanized steel, 0.064 inch thick.
- 6. Blade Axles: Stainless steel.
- 7. Bearings:
 - a. Oil-impregnated bronze.
 - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
- 8. Tie Bars and Brackets: Galvanized steel.
- B. Standard, Aluminum, Manual Volume Dampers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. McGill AirFlow LLC.
 - b. METALAIRE, Inc.
 - c. Nailor Industries Inc.
 - d. Ruskin Company.
 - 2. Standard leakage rating with linkage outside airstream.
 - 3. Suitable for horizontal or vertical applications.
 - 4. Frames: Hat-shaped, 0.10-inch- thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
 - 5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Retain one of first two subparagraphs below.
 - e. Roll-Formed Aluminum Blades: 0.10-inch- thick aluminum sheet.
 - f. Extruded-Aluminum Blades: 0.050-inch- thick extruded aluminum.

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- 6. Blade Axles: Stainless steel.
- 7. Bearings:
 - a. Oil-impregnated bronze.
 - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
- 8. Tie Bars and Brackets: Aluminum.
- C. Low-Leakage, Steel, Manual Volume Dampers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. McGill AirFlow LLC.
 - b. METALAIRE, Inc.
 - c. Nailor Industries Inc.
 - d. Ruskin Company.
 - 2. Low-leakage rating and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
 - 3. Suitable for horizontal or vertical applications.
 - 4. Frames:
 - a. Hat shaped.
 - b. Galvanized steel channels, 0.064 inch thick.
 - c. Mitered and welded corners.
 - d. Flanges for attaching to walls and flangeless frames for installing in ducts.
 - 5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Galvanized, roll-formed steel, 0.064 inch thick.
 - 6. Blade Axles: Stainless steel.
 - 7. Bearings:
 - a. Oil-impregnated bronze.
 - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 - 8. Blade Seals: Vinyl.
 - 9. Jamb Seals: Cambered stainless steel.
 - 10. Tie Bars and Brackets: Galvanized steel.

- 11. Accessories:
 - a. Include locking device to hold single-blade dampers in a fixed position without vibration.
- D. Low-Leakage, Aluminum, Manual Volume Dampers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. McGill AirFlow LLC.
 - b. METALAIRE, Inc.
 - c. Nailor Industries Inc.
 - d. Ruskin Company.
 - 2. Low-leakage rating and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
 - 3. Suitable for horizontal or vertical applications.
 - 4. Frames: Hat shaped, 0.10-inch- thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
 - 5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Roll-Formed Aluminum Blades: 0.10-inch- thick aluminum sheet.
 - d. Extruded-Aluminum Blades: 0.050-inch- thick extruded aluminum.
 - 6. Blade Axles: Stainless steel.
 - 7. Bearings:
 - a. Oil-impregnated bronze.
 - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 - 8. Blade Seals: Vinyl.
 - 9. Jamb Seals: Cambered stainless steel.
 - 10. Tie Bars and Brackets: Galvanized steel.
 - 11. Accessories:
 - a. Include locking device to hold single-blade dampers in a fixed position without vibration.
- E. Jackshaft:
 - 1. Size: 1-inch diameter.
 - 2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.

- 3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.
- F. Damper Hardware:
 - 1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
 - 2. Include center hole to suit damper operating-rod size.
 - 3. Include elevated platform for insulated duct mounting.

2.5 CONTROL DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Greenheck Fan Corporation.
 - 2. Lloyd Industries, Inc.
 - 3. McGill AirFlow LLC.
 - 4. METALAIRE, Inc.
 - 5. Nailor Industries Inc.
 - 6. Ruskin Company.
 - 7. Young Regulator Company.
- B. Low-leakage rating and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
- C. Frames:
 - 1. Hat shaped.
 - 2. Galvanized steel channels, 0.064 inch thick.
 - 3. Mitered and welded corners.
- D. Blades:
 - 1. Multiple blade with maximum blade width of 8 inches.
 - 2. Opposed blade design.
 - 3. Galvanized steel.
 - 4. 0.064 inch thick.
 - 5. Blade Edging: Closed-cell neoprene edging.
 - 6. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.
- E. Blade Axles: 1/2-inch- diameter; stainless steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
 - 1. Operating Temperature Range: From minus 40 to plus 200 deg F.
- F. Bearings:
 - 1. Oil-impregnated bronze.
 - 2. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 - 3. Thrust bearings at each end of every blade.

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2.6 FIRE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Greenheck Fan Corporation.
 - 2. McGill AirFlow LLC.
 - 3. METALAIRE, Inc.
 - 4. Nailor Industries Inc.
 - 5. Ruskin Company.
- B. Type: Dynamic; rated and labeled according to UL 555 by an NRTL.
- C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 4000-fpm velocity.
- D. Fire Rating: 1-1/2 and 3 hours.
- E. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, 0.034inch- thick galvanized steel; with mitered and interlocking corners.
- F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
 - 1. Minimum Thickness: 0.052 or 0.138 inch thick, as indicated, and of length to suit application.
 - 2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
- G. Mounting Orientation: Vertical or horizontal as indicated.
- H. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.
- I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
- J. Heat-Responsive Device: Replaceable, 165 deg F and 212 deg F rated, fusible links.
- K. Heat-Responsive Device: Electric resettable link and switch package, factory installed, 165 deg F and 212 deg F rated.

2.7 CEILING DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. McGill AirFlow LLC.
 - 2. METALAIRE, Inc.
 - 3. Nailor Industries Inc.
 - 4. Ruskin Company.

- B. General Requirements:
 - 1. Labeled according to UL 555C by an NRTL.
 - 2. Comply with construction details for tested floor- and roof-ceiling assemblies as indicated in UL's "Fire Resistance Directory."
- C. Frame: Galvanized sheet steel, round or rectangular, style to suit ceiling construction.
- D. Blades: Galvanized sheet steel with refractory insulation.
- E. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.
- F. Fire Rating: 2 hours.

2.8 COMBINATION FIRE AND SMOKE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Greenheck Fan Corporation.
 - 2. Nailor Industries Inc.
 - 3. Ruskin Company.
- B. Type: Dynamic rated and labeled according to UL 555 and UL 555S by an NRTL.
- C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 4000-fpm velocity.
- D. Fire Rating: 1-1/2 and 3 hours.
- E. Frame: Multiple-blade type; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.
- F. Heat-Responsive Device: Replaceable, 165 deg F and 212 deg F rated, fusible links.
- G. Heat-Responsive Device: Electric resettable link and switch package, factory installed, rated.
- H. Blades: Roll-formed, horizontal, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.
- I. Leakage: Class I.
- J. Rated pressure and velocity to exceed design airflow conditions.
- K. Mounting Sleeve: Factory-installed, 0.052-inch- thick, galvanized sheet steel; length to suit wall or floor application.
- L. Master control panel for use in dynamic smoke-management systems.
- M. Damper Motors: Two-position action.

- N. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23 Section "Instrumentation and Control for HVAC."
 - 3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
 - 4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
 - 5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
 - 6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
 - 7. Electrical Connection: 115 V, single phase, 60 Hz.
- O. Accessories:
 - 1. Auxiliary switches for fan control or position indication.

2.9 FLANGE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ductmate Industries, Inc.
 - 2. Nexus PDQ; Division of Shilco Holdings Inc.
 - 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
- C. Material: Galvanized steel.
- D. Gage and Shape: Match connecting ductwork.

2.10 TURNING VANES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ductmate Industries, Inc.

- 2. METALAIRE, Inc.
- 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
 - 1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
- C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resinbonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards -Metal and Flexible"; Figures 2-3, "Vanes and Vane Runners," and 2-4, "Vane Support in Elbows."
- E. Vane Construction: Double wall.
- F. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.11 REMOTE DAMPER OPERATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. United Emertech
 - 2. Ventfabrics, Inc.
 - 3. Young Regulator Company.
- B. Description: Cable system designed for remote manual damper adjustment.
- C. Tubing: Brass.
- D. Cable: Stainless steel.
- E. Wall-Box Mounting: Recessed, 3/4 inches deep.
- F. Wall-Box Cover-Plate Material: Stainless steel.

2.12 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ductmate Industries, Inc.
 - 2. Flexmaster U.S.A., Inc.
 - 3. Greenheck Fan Corporation.
 - 4. McGill AirFlow LLC.
 - 5. Nailor Industries Inc.

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

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- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels Round Duct."
 - 1. Door:
 - a. Double wall, rectangular.
 - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - c. Vision panel.
 - d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
 - e. Fabricate doors airtight and suitable for duct pressure class.
 - 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
 - 3. Number of Hinges and Locks:
 - a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
 - b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
 - c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches.
 - d. Access Doors Larger than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.
- C. Pressure Relief Access Door:
 - 1. Door and Frame Material: Galvanized sheet steel.
 - 2. Door: Double wall with insulation fill with metal thickness applicable for duct pressure class.
 - 3. Operation: Open outward for positive-pressure ducts and inward for negativepressure ducts.
 - 4. Factory set at 10-inch wg.
 - 5. Doors close when pressures are within set-point range.
 - 6. Hinge: Continuous piano.
 - 7. Latches: Cam.
 - 8. Seal: Neoprene or foam rubber.
 - 9. Insulation Fill: 1-inch- thick, fibrous-glass or polystyrene-foam board.

2.13 DUCT ACCESS PANEL ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ductmate Industries, Inc.
 - 2. Flame Gard, Inc.
 - 3. 3M.
- B. Labeled according to UL 1978 by an NRTL.
- C. Panel and Frame: Minimum thickness 0.0528-inch carbon steel.
- D. Fasteners: Carbon steel. Panel fasteners shall not penetrate duct wall.

- E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.
- F. Minimum Pressure Rating: 10-inch wg, positive or negative.

2.14 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ductmate Industries, Inc.
 - 2. Duro Dyne Inc.
 - 3. Ventfabrics, Inc.
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to 2 strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.
- E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
 - 1. Minimum Weight: 26 oz./sq. yd.
 - 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 - 3. Service Temperature: Minus 40 to plus 200 deg F.
- F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
 - 1. Minimum Weight: 24 oz./sq. yd..
 - 2. Minimum Tensile Strength: 500 lbf/inch in the warp and 440 lbf/inch in the filling.
 - 3. Service Temperature: Minus 50 to plus 250 deg F.
- G. High-Temperature System, Flexible Connectors: Glass fabric coated with silicone rubber.
 - 1. Minimum Weight: 16 oz./sq. yd..
 - 2. Tensile Strength: 285 lbf/inch in the warp and 185 lbf/inch in the filling.
 - 3. Service Temperature: Minus 67 to plus 500 deg F.
- H. High-Corrosive-Environment System, Flexible Connectors: Glass fabric with chemical-resistant coating.
 - 1. Minimum Weight: 14 oz./sq. yd..
 - 2. Tensile Strength: 450 lbf/inch in the warp and 340 lbf/inch in the filling.
 - 3. Service Temperature: Minus 67 to plus 500 deg F.
- I. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.

- 1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
- 2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
- 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
- 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
- 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
- 7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.15 FLEXIBLE DUCTS, THERMALLY INSULATED

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Flexmaster U.S.A., Inc. M-KE
 - 2. McGill AirFlow LLC.
 - 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Insulated, Flexible Duct: UL 181, Class, flexible duct complying with NFPA 90A and 90B. Acoustical flexible duct shall be factory made of CPE liner duct permanently bonded to a coated steel spring steel wire helix and supporting a fiberglass insulating blanket.
 - 1. Pressure Rating: 8-inch wg positive or negative.
 - 2. Maximum Air Velocity: 5000 fpm.
 - 3. Temperature Range: Minus 20 to plus 250 deg F.
 - 4. Insulation R-value: Comply with ASHRAE/IESNA 90.1-2004.
 - 5. Vapor Barrier: 0.05 perms.
- C. Flexible Duct Connectors:
 - 1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.
 - 2. Non-Clamp Connectors: Adhesive plus sheet metal screws.
- D. Warranty: Manufacturer shall provide a 10 year warranty for defects in materials and factory workmanship from date of manufacture.

2.16 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
 - 1. Install steel volume dampers in steel ducts.
 - 2. Install aluminum volume dampers in aluminum ducts.
- E. Set dampers to fully open position before testing, adjusting, and balancing.
- F. Install test holes at fan inlets and outlets and elsewhere as indicated.
- G. Install fire and smoke dampers according to UL listing.
- H. Install duct security bars. Construct duct security bars from 0.164-inch steel sleeve, continuously welded at all joints and 1/2-inch- diameter steel bars, 6 inches o.c. in each direction in center of sleeve. Weld each bar to steel sleeve and each crossing bar. Weld 2-1/2-by-2-1/2-by-1/4-inch steel angle to 4 sides and both ends of sleeve. Connect duct security bars to ducts with flexible connections. Provide 12-by-12-inch hinged access panel with cam lock in duct in each side of sleeve.
- I. Connect ducts to duct silencers rigidly.
- J. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - 1. On both sides of duct coils.
 - 2. Upstream and downstream from duct filters.
 - 3. At outdoor-air intakes and mixed-air plenums.
 - 4. At drain pans and seals.
 - 5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
 - 6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors

installed upstream from dampers and inward operation for access doors installed downstream from dampers.

- 7. At each change in direction and at maximum 50-foot spacing.
- 8. Upstream and downstream from turning vanes.
- 9. Upstream or downstream from duct silencers.
- 10. Control devices requiring inspection.
- 11. Elsewhere as indicated.
- K. Install access doors with swing against duct static pressure.
- L. Access Door Sizes:
 - 1. One-Hand or Inspection Access: 8 by 5 inches.
 - 2. Two-Hand Access: 12 by 6 inches.
 - 3. Head and Hand Access: 18 by 10 inches.
 - 4. Head and Shoulders Access: 21 by 14 inches.
 - 5. Body Access: 25 by 14 inches.
 - 6. Body plus Ladder Access: 25 by 17 inches.
- M. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- N. Install flexible connectors to connect ducts to equipment.
- O. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- P. Connect terminal units to supply ducts directly. Do not use flexible ducts to change directions.
- Q. Connect diffusers or light troffer boots to ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.
- R. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.
- S. Install duct test holes where required for testing and balancing purposes.
- T. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.2 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Operate dampers to verify full range of movement.
 - 2. Inspect locations of access doors and verify that purpose of access door can be performed.
 - 3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
 - 4. Inspect turning vanes for proper and secure installation.
 - 5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF DOCUMENT 23 3300

SECTION 23 3413 AXIAL HVAC FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Tubeaxial fans.
 - 2. Vaneaxial fans.

1.3 **PERFORMANCE REQUIREMENTS**

- A. Project Altitude: Base fan performance ratings on sea level.
- B. Operating Limits: Classify according to AMCA 99.

1.4 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
 - 1. Certified fan performance curves with system operating conditions indicated.
 - 2. Certified fan sound-power ratings.
 - 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 4. Material thickness and finishes, including color charts.
 - 5. Dampers, including housings, linkages, and operators.
 - 6. Fan speed controllers.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
 - 2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
 - 3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For axial fans to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

Project No. 121505 Axial HVAC Fans Section 23 3413 - 1

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
- C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations, with protective crating and covering.
- B. Disassemble and reassemble units, as required for moving to final locations, according to manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.

1.7 COORDINATION

- A. Coordinate size and location of structural-steel support members.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Belts: One set(s) for each belt-driven unit.

PART 2 - PRODUCTS

2.1 VANEAXIAL FANS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. Greenheck.
 - 2. Loren Cook Company.
- B. Description: Fan wheel and housing, straightening vane section, factory-mounted motor with direct drive and accessories.
- C. Housings: Galvanized steel:
 - 1. Inlet and Outlet Connections: Flanges.

- D. Wheel Assemblies: Cast aluminum with airfoil-shaped blades mounted on cast-iron wheel plate keyed to shaft with solid-steel key.
- E. Wheel Assemblies: Cast-aluminum hub assembly, machined and fitted with threaded bearing wells to receive blade-bearing assemblies with replaceable, cast-aluminum blades; factory mounted and balanced.
- F. Drives: Factory mounted, with final alignment.
 - 1. Service Factor Based on Fan Motor Size: 1.2.
 - 2. Fan Shaft: Turned, ground, and polished steel designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
 - 3. Motor Mount: Adjustable base.
 - 4. Shaft Bearings: Radial, self-aligning ball or roller bearings.
 - a. Ball-Bearing Rating Life: ABMA 9, L10 of 100,000 hours.
 - b. Roller-Bearing Rating Life: ABMA 11, L10 of 100,000 hours.
 - c. Extend lubrication lines to outside of casing and terminate with grease fittings.
- G. Accessories:
 - 1. Companion Flanges: Rolled flanges of same material as housing.
 - 2. Inspection Door: Bolted door allowing limited access to internal parts of fan, of same material as housing.
 - 3. Propeller Access Section Door: Short duct section bolted to fan inlet and outlet allowing access to internal parts of fan for inspection and cleaning, of same material as housing.
 - 4. Swingout Construction: Assembly allowing entire fan section to swing out from duct for cleaning and servicing, of same material as housing.
 - 5. Mounting Clips: Vertical mounting clips welded to fan housing, of same material as housing.
 - 6. Horizontal Support: Pair of supports bolted to fan housing, of same material as housing.
 - 7. Vertical Support: Short duct section with welded brackets bolted to fan housing, of same material as housing.
 - 8. Inlet and Outlet Screens: Wire-mesh screen on fans not connected to ductwork of same material as housing.
 - 9. Backdraft Dampers: Butterfly style, for mounting with flexible connection to the discharge of fan or direct mounted to the discharge diffuser section of same material as housing.

- 10. Stall Alarm Probe: Sensing probe capable of detecting fan operation in stall and signaling control devices. Control devices and sequence of operation are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls."
- 11. Flow Measurement Port: Pressure measurement taps installed in the inlet of fan to detect and signal airflow readings to temperature-control systems. Control devices and sequence of operation are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls."
- 12. Shaft Seal: Elastomeric seal and Teflon wear plate, suitable for up to300 deg F.
- 13. Motor Cover: Cover with side vents to dissipate motor heat, of same material as housing.
- 14. Inlet Bell: Curved inlet for when fan is not attached to duct, of same material as housing.
- 15. Inlet Cones: Round-to-round transition of same material as housing.
- 16. Outlet Cones: Round-to-round transition of same material as housing.
- 17. Stack Cap: Vertical discharge assembly with backdraft dampers, of same material as housing.
- H. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 - 1. Enclosure Type: Totally enclosed, fan cooled.
 - 2. Direct-Driven Units: Encase motor in housing outside of airstream, factory wired to disconnect switch located on outside of fan housing.
- I. Factory Finishes:
 - 1. Sheet Metal Parts: Prime coat before final assembly.
 - 2. Exterior Surfaces: Baked-enamel finish coat after assembly.
 - 3. Coatings: Thermoplastic vinyl:

a. Apply to finished housings. b. Apply to fan wheels.

2.2 SOURCE QUALITY CONTROL

- A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install axial fans level and plumb.
- B. Support floor-mounting units using restrained spring isolators having a static deflection of 1 inch. Vibration- and seismic-control devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
 - 1. Secure vibration and seismic controls to concrete bases using anchor bolts cast in concrete base.
- C. Install floor-mounting units on concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."
- D. Install floor-mounting units on concrete bases designed to withstand, without damage to equipment, the seismic force required by authorities having jurisdiction. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."
- E. Support suspended units from structure using threaded steel rods and spring hangers having a static deflection of 1 inch. Vibration-control devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- F. Install units with clearances for service and maintenance.
- G. Label fans according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories."
- B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 3. Verify that cleaning and adjusting are complete.
 - 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system and align.
 - 5. Adjust damper linkages for proper damper operation.

Project No. 121505 Axial HVAC Fans Section 23 3413 - 5

- 6. Verify lubrication for bearings and other moving parts.
- 7. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
- 8. Disable automatic temperature-control operators, energize motor and confirm proper motor rotation and unit operation, adjust fan to indicated rpm, and measure and record motor voltage and amperage.
- 9. Shut unit down and reconnect automatic temperature-control operators.
- 10. Remove and replace malfunctioning units and retest as specified above.
- B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Lubricate bearings.

END OF DOCUMENT 23 3413

SECTION 23 3416 CENTRIFUGAL HVAC FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Airfoil centrifugal fans.
 - 2. Backward-inclined centrifugal fans.
 - 3. Forward-curved centrifugal fans.
 - 4. Plenum fans.
 - 5. Plug fans.

1.3 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base fan performance ratings on sea level.
- B. Operating Limits: Classify according to AMCA 99.

1.4 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
 - 1. Certified fan performance curves with system operating conditions indicated.
 - 2. Certified fan sound-power ratings.
 - 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 4. Material thickness and finishes, including color charts.
 - 5. Dampers, including housings, linkages, and operators.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
 - 2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
 - 3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.
- C. Coordination Drawings: Show fan room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.

- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For centrifugal fans to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
- C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA 1.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations, with protective crating and covering.
- B. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.

1.7 COORDINATION

- A. Coordinate size and location of structural-steel support members.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Belts: One set(s) for each belt-driven unit.

PART 2 - PRODUCTS

2.1 AIRFOIL CENTRIFUGAL FANS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Greenheck.
 - 2. Loren Cook Company.
 - 3. Trane.

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

Project No. 121505 Centrifugal HVAC Fans Section 23 3416 - 2

- B. Description: Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor drive assembly, and support structure.
- C. Housings: Formed panels to make curved-scroll housings with shaped cutoff, with doors or panels to allow access to internal parts and components.
 - 1. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
 - 2. Spun inlet cone with flange.
 - 3. Outlet flange.
- D. Airfoil Wheels: Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange; heavy backplate; hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate; cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws; and special coating.
- E. Shafts: Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
 - 1. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
 - 2. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
- F. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
 - 1. Ball-Bearing Rating Life: ABMA 9, LI0 at 120,000 hours.
 - 2. Roller-Bearing Rating Life: ABMA 11, LI0 at 120,000 hours.
- G. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
 - 1. Service Factor Based on Fan Motor Size: 1.2.
 - 2. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
 - 3. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
 - 4. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
 - 5. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
 - 6. Motor Mount: Adjustable for belt tensioning.
- H. Accessories:
 - 1. Scroll Access Doors: Shaped to conform to scroll, with quick-opening latches and gaskets.

- 2. Cleanout Door: Bolted gasketed door allowing access to fan scroll, of same material as housing.
- 3. Scroll Drain Connection: NPS 1 steel pipe coupling welded to low point of fan scroll.
- 4. Companion Flanges: Rolled flanges for duct connections of same material as housing.
- 5. Inlet Screens: Grid screen of same material as housing.
- 6. Spark-Resistant Construction: AMCA 99.
- 7. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
- 8. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.
- I. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 - 1. Enclosure Type: Totally enclosed, fan cooled.

2.2 BACKWARD-INCLINED CENTRIFUGAL FANS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Loren Cook Company.
 - 2. Trane.
 - 3. Greenheck
- B. Description: Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor drive assembly, and support structure.
- C. Housings: Formed panels to make curved-scroll housings with shaped cutoff; with doors or panels to allow access to internal parts and components.
 - 1. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
 - 2. Spun inlet cone with flange.
 - 3. Outlet flange.
- D. Backward-Inclined Wheels: Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange, backplate, backward-inclined blades welded or riveted to flange and backplate; cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.
- E. Shafts: Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
 - 1. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
 - 2. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
- F. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
 - 1. Ball-Bearing Rating Life: ABMA 9, LI0 at 120,000 hours.
 - 2. Roller-Bearing Rating Life: ABMA 11, LI0 at 120,000 hours.

- G. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
 - 1. Service Factor Based on Fan Motor Size: 1.2.
 - 2. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
 - 3. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
 - 4. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
 - Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
 - 6. Motor Mount: Adjustable for belt tensioning.
- H. Accessories:
 - 1. Scroll Access Doors: Shaped to conform to scroll, with quick-opening latches and gaskets.
 - 2. Cleanout Door: Bolted gasketed door allowing access to fan scroll, of same material as housing.
 - 3. Scroll Drain Connection: NPS 1 steel pipe coupling welded to low point of fan scroll.
 - 4. Companion Flanges: Rolled flanges for duct connections of same material as housing.
 - 5. Inlet Screens: Grid screen of same material as housing.
 - 6. Spark-Resistant Construction: AMCA 99.
 - 7. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
 - 8. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.
- I. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 - 1. Enclosure Type: Totally enclosed, fan cooled.

2.3 FORWARD-CURVED CENTRIFUGAL FANS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. Loren Cook Company.
 - 2. Trane.
 - 3. Greenheck.
- B. Description: Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor drive assembly, and support structure.
- C. Housings: Formed panels to make curved-scroll housings with shaped cutoff; with doors or panels to allow access to internal parts and components.
 - 1. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.

- 2. Spun inlet cone with flange.
- 3. Outlet flange.
- D. Forward-Curved Wheels: Black-enameled or galvanized steel construction with inlet flange, backplate, shallow blades with inlet and tip curved forward in direction of airflow, mechanically secured to flange and backplate; cast-steel hub swaged to backplate and fastened to shaft with set screws.
- E. Shafts: Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
 - 1. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
 - 2. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
- F. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
 - 1. Ball-Bearing Rating Life: ABMA 9, LI0 at 120,000 hours.
 - 2. Roller-Bearing Rating Life: ABMA 11, LI0 at 120,000 hours.
- G. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
 - 1. Service Factor Based on Fan Motor Size: 1.2.
 - 2. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
 - 3. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
 - 4. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
 - 5. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
 - 6. Motor Mount: Adjustable for belt tensioning.
- H. Accessories:
 - 1. Scroll Access Doors: Shaped to conform to scroll, with quick-opening latches and gaskets.
 - 2. Cleanout Door: Bolted gasketed door allowing access to fan scroll, of same material as housing.
 - 3. Scroll Drain Connection: NPS 1 steel pipe coupling welded to low point of fan scroll.
 - 4. Companion Flanges: Rolled flanges for duct connections of same material as housing.
 - 5. Inlet Screens: Grid screen of same material as housing.
 - 6. Spark-Resistant Construction: AMCA 99.
 - 7. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
 - 8. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.

- I. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 - 1. Enclosure Type: Totally enclosed, fan cooled.

2.4 PLENUM FANS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. Loren Cook Company.
 - 2. Trane.
 - 3. Greenheck
- B. Description: Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of wheel, fan shaft, bearings, motor, drive assembly, and support structure.
- C. Airfoil Wheels: Single-width-single-inlet construction with smooth-curved inlet flange; heavy backplate; hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate; cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws; and special coating.
- D. Shafts: Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
 - 1. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
 - 2. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
- E. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
 - 1. Ball-Bearing Rating Life: ABMA 9, LI0 at 120,000 hours.
 - 2. Roller-Bearing Rating Life: ABMA 11, LI0 at 120,000 hours.
- F. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
 - 1. Service Factor Based on Fan Motor Size: 1.2.
 - 2. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
 - 3. 5-hp limit in first subparagraph below is standard with many manufacturers but is designer's choice.
 - 4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.

- 5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
- 6. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
- 7. Motor Mount: Adjustable for belt tensioning.
- G. Accessories:
 - 1. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
- H. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 - 1. Enclosure Type: Totally enclosed, fan cooled.

2.5 PLUG FANS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. Loren Cook Company.
 - 2. Trane.
 - 3. Greenheck
- B. Description: Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of wheel, fan shaft, bearings, motor, drive assembly, and support structure.
- C. Airfoil Wheels: Single-width-single-inlet construction with smooth-curved inlet flange; heavy backplate; hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate; cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws; and special coating.
- D. Shafts: Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
 - 1. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
 - 2. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
- E. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
 - 1. Ball-Bearing Rating Life: ABMA 9, LI0 at 120,000 hours.
 - 2. Roller-Bearing Rating Life: ABMA 11, LI0 at 120,000 hours.

- F. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
 - 1. Service Factor Based on Fan Motor Size: 1.2.
 - 2. Fan Pulleys: Cast iron or cast steel with split tapered bushing; dynamically balanced at factory.
 - 3. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
 - 4. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
 - 5. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
 - 6. Motor Mount: Adjustable for belt tensioning.
- G. Accessories:
 - 1. Spark-Resistant Construction: AMCA 99.
 - 2. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
- H. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 - 1. Enclosure Type: Totally enclosed, fan cooled.

2.6 SOURCE QUALITY CONTROL

- A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install centrifugal fans level and plumb.
- B. Support floor-mounting units using spring isolators having a static deflection of 1 inch. Vibration- and seismic-control devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
 - 1. Secure vibration and seismic controls to concrete bases using anchor bolts cast in concrete base.

- C. Install floor-mounting units on concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."
- D. Install floor-mounting units on concrete bases designed to withstand, without damage to equipment, the seismic force required by authorities having jurisdiction. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."
- E. Support suspended units from structure using threaded steel rods and spring hangers having a static deflection of 1 inch. Vibration-control devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- F. Install units with clearances for service and maintenance.
- G. Label fans according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories."
- B. Install ducts adjacent to fans to allow service and maintenance.
- C. Install line-sized piping from scroll drain connection, with trap with seal equal to 1.5 times specified static pressure, to nearest floor drain.
- D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 3. Verify that cleaning and adjusting are complete.
 - 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 - 5. Adjust belt tension.
- 6. Adjust damper linkages for proper damper operation.
- 7. Verify lubrication for bearings and other moving parts.
- 8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
- 9. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
- 10. Remove and replace malfunctioning units and retest as specified above.
- B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain centrifugal fans. Refer to Division 01 Section "Demonstration and Training."

END OF DOCUMENT 23 3416

SECTION 23 3423 HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Utility set fans.
 - 2. Centrifugal roof ventilators.
 - 3. Axial roof ventilators.
 - 4. Upblast propeller roof exhaust fans.
 - 5. Centrifugal wall ventilators.
 - 6. Ceiling-mounting ventilators.
 - 7. In-line centrifugal fans.
 - 8. Propeller fans.

1.3 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base fan-performance ratings on sea level.
- B. Operating Limits: Classify according to AMCA 99.

1.4 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
 - 1. Certified fan performance curves with system operating conditions indicated.
 - 2. Certified fan sound-power ratings.
 - 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 4. Material thickness and finishes, including color charts.
 - 5. Dampers, including housings, linkages, and operators.
 - 6. Roof curbs.
 - 7. Fan speed controllers.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection:
 - 1. Wiring Diagrams: Power, signal, and control wiring.
 - 2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
 - 3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.
- C. Field quality-control test reports.

D. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
- C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
- D. UL Standard: Power ventilators shall comply with UL 705.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.
- B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.

1.7 COORDINATION

- A. Coordinate size and location of structural-steel support members.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Belts: One set(s) for each belt-driven unit.

PART 2 - PRODUCTS

2.1 UTILITY SET FANS

- A. Manufacturers: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - 1. Loren Cook Company.
 - 2. Penn Ventilation.

- 3. Greenheck.
- B. Description: Belt driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and accessories.
- C. Housing: Fabricated of galvanized steel with side sheets fastened with a deep lock seam or welded to scroll sheets.
 - 1. Housing Discharge Arrangement: Adjustable to eight standard positions.
- D. Fan Wheels: Single-width, single inlet; welded to cast-iron or cast-steel hub and spunsteel inlet cone, with hub keyed to shaft.
 - 1. Blade Materials: Aluminum.
 - 2. Blade Type: Backward inclined, forward curved or Airfoil.
 - 3. Spark-Resistant Construction: AMCA 99, Type A.
- E. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
- F. Shaft Bearings: Prelubricated and sealed, self-aligning, pillow-block-type ball bearings with ABMA 9, L₅₀ of 200,000 hours.
- G. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
 - 1. Service Factor Based on Fan Motor Size: 1.2.
 - 2. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
 - 3. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
 - 4. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.
- H. Accessories:
 - 1. Inlet and Outlet: Flanged.
 - 2. Companion Flanges: Rolled flanges for duct connections of same material as housing.
 - 3. Backdraft Dampers: Gravity actuated with counterweight and interlocking aluminum blades with felt edges in steel frame installed on fan discharge.
 - 4. Access Door: Gasketed door in scroll with latch-type handles.
 - 5. Inlet Screens: Removable wire mesh.
 - 6. Drain Connections: NPS 3/4 threaded coupling drain connection installed at lowest point of housing.
 - 7. Weather Hoods: Weather resistant with stamped vents over motor and drive compartment.
 - 8. Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
- I. Coatings: Thermoplastic vinyl.

2.2 CENTRIFUGAL ROOF VENTILATORS

- A. Manufacturers: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - 1. Acme Engineering & Mfg. Corp.
 - 2. Greenheck.
 - 3. Loren Cook Company.
 - 4. Penn Ventilation
- B. Description: Direct- or belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.
- C. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.
 - 1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains and grease collector.
 - 2. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.
- D. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
- E. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:
 - 1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 - 2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
 - 3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
 - 4. Fan and motor isolated from exhaust airstream.
- F. Accessories:
 - 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 - 2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
 - 3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
 - 4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
 - 5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
- G. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.
 - 1. Configuration: Built-in cant and mounting flange.
 - 2. Overall Height: 18 inches.
 - 3. Sound Curb: Curb with sound-absorbing insulation matrix.
 - 4. Pitch Mounting: Manufacture curb for roof slope.

- 5. Metal Liner: Galvanized steel.
- 6. Mounting Pedestal: Galvanized steel with removable access panel.
- 7. Vented Curb: Unlined with louvered vents in vertical sides.

2.3 AXIAL ROOF VENTILATORS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Acme Engineering & Mfg. Corp.
 - 2. Greenheck.
 - 3. Loren Cook Company.
 - 4. Penn Ventilation.
- B. Description: Direct- or belt-driven axial fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.
- C. Housing: Heavy-gage, removable, spun-aluminum, dome top and outlet baffle; square, one-piece, hinged, aluminum base.
 - 1. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.
- D. Fan Wheel: Aluminum hub and blades.
- E. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:
 - 1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 - 2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
 - 3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
- F. Accessories:
 - 1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
 - 2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
 - 3. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
 - 4. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
- G. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.
 - 1. Configuration: Built-in cant and mounting flange.
 - 2. Overall Height: 18 inches.
 - 3. Sound Curb: Curb with sound-absorbing insulation matrix.

TLC Engineering Solutions

Project No. 121505 HVAC Power Ventilators Section 23 3423 - 5

- 4. Pitch Mounting: Manufacture curb for roof slope.
- 5. Metal Liner: Galvanized steel.
- 6. Mounting Pedestal: Galvanized steel with removable access panel.

2.4 UPBLAST PROPELLER ROOF EXHAUST FANS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Acme Engineering & Mfg. Corp.
 - 2. Greenheck.
 - 3. Loren Cook Company.
 - 4. Penn Ventilation.
- B. Description: Direct- or belt-driven propeller fans consisting of housing, wheel, butterflytype discharge damper, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.
- C. Wind Band, Fan Housing, and Base: Reinforced and braced aluminum, containing aluminum butterfly dampers and rain trough, motor and drive assembly, and fan wheel.
 - 1. Damper Rods: Steel with nylon bearings.
 - 2. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.
- D. Fan Wheel: Replaceable, extruded aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.
- E. Belt-Driven Drive Assembly: Resiliently mounted to housing; weatherproof housing of same material as fan housing with the following features:
 - 1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 - 2. Shaft Bearings: Prelubricated and sealed, self-aligning, pillow-block-type ball bearings.
 - 3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
 - 4. Motor Mount: On outside of fan cabinet, adjustable base for belt tensioning.
- F. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.
 - 1. Configuration: Built-in cant and mounting flange.
 - 2. Overall Height: 18 inches.
 - 3. Sound Curb: Curb with sound-absorbing insulation matrix.
 - 4. Pitch Mounting: Manufacture curb for roof slope.
 - 5. Metal Liner: Galvanized steel.
 - 6. Mounting Pedestal: Galvanized steel with removable access panel.

2.5 IN-LINE CENTRIFUGAL FANS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Acme Engineering & Mfg. Corp.
 - 2. Greenheck.
 - 3. Loren Cook Company.
 - 4. Penn Ventilation.
- B. Description: In-line, belt driven centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, motor and disconnect switch, drive assembly, mounting brackets, and accessories.
- C. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.
- D. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.
- E. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.
- F. Accessories:
 - 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 - 2. Companion Flanges: For inlet and outlet duct connections.
 - 3. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
 - 4. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.

2.6 MOTORS

- A. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
- B. Enclosure Type: Totally enclosed, fan cooled.

2.7 SOURCE QUALITY CONTROL

- A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install power ventilators level and plumb.
- B. Support units using spring isolators having a static deflection of 1 inch. Vibration- and seismic-control devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
 - 1. Secure vibration and seismic controls to concrete bases using anchor bolts cast in concrete base.
- C. Install floor-mounting units on concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."
- D. Install floor-mounting units on concrete bases designed to withstand, without damage to equipment, the seismic force required by code. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."
- E. Secure roof-mounting fans to roof curbs with cadmium-plated hardware. Refer to Division 07 Section "Roof Accessories" for installation of roof curbs.
- F. Ceiling Units: Suspend units from structure; use steel wire or metal straps.
- G. Support suspended units from structure using threaded steel rods and spring hangers having a static deflection of 1 inch. Vibration-control devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- H. Install units with clearances for service and maintenance.
- I. Label units according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories."
- B. Install ducts adjacent to power ventilators to allow service and maintenance.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Verify that shipping, blocking, and bracing are removed.

- 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
- 3. Verify that cleaning and adjusting are complete.
- 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
- 5. Adjust belt tension.
- 6. Adjust damper linkages for proper damper operation.
- 7. Verify lubrication for bearings and other moving parts.
- 8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
- 9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
- 10. Shut unit down and reconnect automatic temperature-control operators.
- 11. Remove and replace malfunctioning units and retest as specified above.
- B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
- D. Replace fan and motor pulleys as required to achieve design airflow.
- E. Lubricate bearings.

END OF DOCUMENT 23 3423

SECTION 23 3600 AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Shutoff, single-duct air terminal units.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC

1.4 SUBMITTALS

- A. Product Data: For each type of the following products, including rated capacities, furnished specialties, sound-power ratings, and accessories.
 - 1. Air terminal units.
 - 2. Liners and adhesives.
 - 3. Sealants and gaskets.

B. LEED Submittal:

- 1. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1-2004, Section 5 "Systems and Equipment."
- C. Shop Drawings: For air terminal units. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.
 - 3. Hangers and supports, including methods for duct and building attachment and vibration isolation.
- D. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
 - 1. Ceiling suspension assembly members.
 - 2. Size and location of initial access modules for acoustic tile.
 - 3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

- E. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Instructions for resetting minimum and maximum air volumes.
 - 2. Instructions for adjusting software set points.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 "Systems and Equipment" and Section 7 "Construction and System Start-Up."

PART 2 - PRODUCTS

2.1 SHUTOFF, SINGLE-DUCT AIR TERMINAL UNITS

- A. Manufacturers: Subject to compliance with requirements, provide product indicated on drawings or one of the following:
 - 1. Trane; a business of American Standard Companies.
- B. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.
- C. Casing: 0.034-inch steel, double wall.
 - 1. Casing Lining: Adhesive attached, 1-inch thick, coated, fibrous-glass duct liner complying with ASTM C 1071, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
 - a. Cover liner with nonporous foil and perforated metal.
 - 2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
 - 3. Air Outlet: S-slip and drive connections.
 - 4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
 - 5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
- D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
 - 1. Maximum Damper Leakage: ARI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.
 - 2. Damper Position: Normally closed.

E. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.

2.2 AIRFLOW CONTROL DEVICE—GENERAL

- A. The airflow control device shall be a venturi valve.
 - 1. Maintenance shall be from Tek-Air, Siemens or equal.
- B. The valve assembly manufacturer's Quality Management System shall be registered to ISO 9001:2000.
- C. The airflow control device shall be pressure independent over its specified differential static pressure operating range. An integral pressure independent assembly shall respond and maintain specific airflow within one second of a change in duct static pressure irrespective of the magnitude of pressure and/or flow change or quantity of airflow controllers on a manifolded system.
- D. The airflow control device shall maintain accuracy within ±5% of signal over an airflow turndown range of no less than 16 to 1.
- E. No minimum entrance or exit duct diameters shall be required to ensure accuracy and/or pressure independence.
- F. The airflow control device shall be constructed of one of the following three types:
 - 1. Class A The airflow control device for non-corrosive airstreams, such as supply and general exhaust, shall be constructed of 16-gauge aluminum. The device's shaft and shaft support brackets shall be made of 316 stainless steel. The pivot arm and internal mounting link shall be made of aluminum. The pressure independent springs shall be a spring-grade stainless steel. All shaft bearing surfaces shall be made of aTeflon, polyester or PPS (polyphenylene sulfide) composite.

Sound attenuating devices used in conjunction with general exhaust or supply airflow control devices shall be constructed using 24 gauge galvanized steel or other suitable material used in standard duct construction. No sound absorptive materials of any kind shall be used.

- G. Actuation:
 - For electrically actuated VAV operation, a UL 916 listed electronic actuator shall be factory mounted to the valve. Loss of main power shall cause the valve to position itself in an appropriate failsafe state. Options for these failsafe states include: normally open-maximum position, normally closed-minimum position and last position. This position shall be maintained constantly without external influence, regardless of external conditions on the valve (within product specifications).
 - 2. Constant volume valves do not require actuators.
- H. The controller for the airflow control devices shall be microprocessor based and operate using peer-to-peer control architecture. The room-level airflow control devices shall function as a standalone network.

- I. The room-level control network shall utilize a BACnet communications protocol.
- J. There shall be no reliance on external or building-level control devices to perform roomlevel control functions. Each laboratory control system shall have the capability of performing fume hood control, pressurization control, temperature control, humidity control, and implement occupancy and emergency mode control schemes.
- K. Certification:
 - Each airflow control device shall be factory calibrated to the job specific airflows as detailed on the plans and specifications using NIST traceable air stations and instrumentation having a combined accuracy of no more than ±1% of signal over the entire range of measurement. Electronic airflow control devices shall be further calibrated and their accuracy verified to ±5% of signal at a minimum of 48 different airflows across the full operating range of the device.
 - 2. Each airflow control devices shall be marked with device-specific factory calibration data. At a minimum, it should include the tag number, serial number, model number, eight-point characterization information (for electronic devices), and quality control inspection numbers. All information shall be stored by the manufacturer for use with as-built documentation.

2.3 EXHAUST AND SUPPLY AIRFLOW DEVICE CONTROLLER

- A. The airflow control device shall be a microprocessor-based design and shall use closed loop control to linearly regulate airflow based on a digital control signal. The device shall generate a digital feedback signal that represents its airflow.
- B. The airflow control device shall store its control algorithms in non-volatile, re-writeable memory. The device shall be able to stand-alone or to be networked with other room-level digital airflow control devices using an industry standard protocol.
- C. Room-level control functions shall be embedded in and carried out by the airflow device controller using distributed control architecture. Critical control functions shall be implemented locally; no room-level controller shall be required.
- D. The airflow control device shall use industry standard 24 VAC power.
- E. The airflow control device shall have provisions to connect a notebook PC commissioning tool and every node on the network shall be accessible from any point in the system.
- F. The airflow control device shall have built-in integral input/output connections that address fume hood control, temperature control, humidity control occupancy control, emergency control, and non-network sensors switches and control devices. At a minimum, the airflow controller shall have:
 - 1. Three universal inputs capable of accepting 0 to 10 Vdc, 4 to 20 mA, 0 to 65 K ohms, or Type 2 or Type 3 10 K ohm @ 25 degree C thermistor temperature sensors.
 - 2. One digital input capable of accepting a dry contact or logic level signal input.
 - 3. Two analog outputs capable of developing either a 0 to 10 Vdc or 4 to 20 mA linear control signal.
 - 4. One Form C (SPDT) relay output capable of driving up to 1 A @ 24 Vac/Vdc.

G. The airflow control device shall meet FCC Part 15 Subpart J Class A and be UL916 listed.

2.4 CONSTANT VOLUME AIRFLOW CONTROL DEVICE

A. The airflow control device shall maintain a constant airflow set point. It shall be factory calibrated and set for the desired airflow. It shall also be capable of field adjustment for future changes in desired airflow.

2.5 CONTROL FUNCTIONS

- A. The airflow control devices shall utilize peer-to-peer, distributed control architecture to perform room-level control functions. Master-slave control schemes shall not be acceptable. Control functions shall include, at a minimum, pressurization, temperature, humidity control, as well as respond to occupancy and emergency control commands.
- B. Pressurization Control:
 - a. The control system shall control supply and auxiliary exhaust airflow devices in order to maintain a volumetric offset (either positive or negative). Offset shall be maintained regardless of any change in flow or static pressure. This offset shall be field adjustable and represents the volume of air, which will enter (or exit) the room from the corridor or adjacent spaces.
 - b. The pressurization control algorithm shall sum the flow values of all supply and exhaust airflow devices and command appropriate controlled devices to new set points to maintain the desired offset. The offset shall be adjustable.
 - C. The pressurization control algorithm shall consider both networked devices, as well as:
 - 1. Up to three non-networked devices providing a linear analog flow signal.
 - 2. Any number of constant volume devices where the total of supply devices and the total of exhaust devices may be factored into the pressurization control algorithm.
 - d. Volumetric offset shall be the only acceptable means of controlling room pressurization. Systems that rely on differential pressure as a means of control shall provide documentation to demonstrate that space pressurization can be maintained if fume hood sashes are changed at the same time a door to the space is opened.
 - e. The pressurization control algorithm shall support the ability to regulate the distribution of total supply flow across multiple supply airflow control devices in order to optimize air distribution in the space.
- C. Local Alarm Control:
 - 1. All points shall be available through the interface to the BCS for trending, archiving, graphics, alarm notification and status reports. Airflow control system performance (speed, stability and accuracy) shall be unaffected by the quantity of points being monitored, processed or controlled.

2. Refer to the BCS specification for the required input/output summary for the necessary points to be monitored and/or controlled.

2.6 INTERFACE TO BUILDING CONTROL SYSTEMS

- A. All room-level points shall be available to the BCS for monitoring or trending. The gateway shall maintain a cache of all points to be monitored by the BCS. The room-level airflow control devices shall update this cache continually.
- B. The building-level network shall be a high-speed BACNet MS/TP communications protocol. The building-level network shall support up to 100 zones, or 6000 data points.
- C. A commercially available network interface card shall be provided with the gateway to interface with the BCS.

2.7 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Steel Cables: Galvanized steel complying with ASTM A 603.
- D. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- E. Air Terminal Unit Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- F. Trapeze and Riser Supports: Steel shapes and plates for units with steel casings; aluminum for units with aluminum casings.

2.8 SOURCE QUALITY CONTROL

- A. Factory Tests: Test assembled air terminal units according to ARI 880.
 - 1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type and ARI certification seal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
- B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.
- C. Install wall-mounted thermostats.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Chapter 4, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Where practical, install concrete inserts before placing concrete.
 - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than 4 inches thick.
 - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches thick.
- C. Hangers Exposed to View: Threaded rod and angle or channel supports.
- D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.3 CONNECTIONS

- A. Install piping adjacent to air terminal unit to allow service and maintenance.
- B. Hot-Water Piping: In addition to requirements in Division 23 Section "Hydronic Piping," connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.
- C. Connect ducts to air terminal units according to Division 23 Section "Metal Ducts".
- D. Make connections to air terminal units with flexible connectors complying with requirements in Division 23 Section "Air Duct Accessories."

3.4 IDENTIFICATION

 A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Division 23 Section "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
 - 1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.

- 2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
- 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
- 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Air terminal unit will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.6 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
 - 3. Verify that controls and control enclosure are accessible.
 - 4. Verify that control connections are complete.
 - 5. Verify that nameplate and identification tag are visible.
 - 6. Verify that controls respond to inputs as specified.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION 23 3600

SECTION 23 3713 DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Rectangular and square ceiling diffusers.
 - 2. Louver face diffusers.
 - 3. Linear bar diffusers.
 - 4. Linear slot diffusers.
 - 5. Ceiling-integral continuous diffusers.
 - 6. Fixed face registers and grilles.
 - 7. Linear bar grilles.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated, include the following:
 - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
 - 2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.
- B. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
 - 1. Ceiling suspension assembly members.
 - 2. Method of attaching hangers to building structure.
 - 3. Size and location of initial access modules for acoustical tile.
 - 4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers,
 - sprinklers, access panels, and special moldings.
 - 5. Duct access panels.
- C. Source quality-control reports.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS

- A. Rectangular and Square Ceiling Diffusers:
 - 1. Manufacturers: Subject to compliance with requirements. Provide product indicated on drawings or one of the following:
 - a. METALAIRE, Inc.
 - b. Nailor Industries Inc.

- c. Price Industries.
- d. Titus.
- 2. Material: Aluminum.
- 3. Finish: Baked enamel, white.
- 4. Face Size: 24 by 24 inches.
- 5. Mounting: T-bar.
- 6. Pattern: Fixed.
- 7. Accessories:
 - a. Plaster ring.
 - b. Sectorizing baffles.
- B. Louver Face Diffuser:
 - 1. Manufacturers: Subject to compliance with requirements. Provide product indicated on drawings or one of the following:
 - a. METALAIRE, Inc.
 - b. Nailor Industries Inc.
 - c. Price Industries.
 - d. Titus.
 - 2. Devices shall be specifically designed for variable-air-volume flows.
 - 3. Material: Aluminum.
 - 4. Finish: Baked enamel, white.
 - 5. Mounting: Surface.
 - 6. Pattern: Two-way core style.
 - 7. Accessories:
 - a. Square to round neck adaptor.
 - b. Adjustable pattern vanes.
 - c. Throw reducing vanes.
 - d. Equalizing grid.
 - e. Plaster ring.
 - f. Sectorizing baffles.

2.2 CEILING LINEAR SLOT OUTLETS

- A. Linear Bar Diffuser:
 - 1. Manufacturers: Subject to compliance with requirements. Provide product indicated on drawings or one of the following:
 - a. METALAIRE, Inc.
 - b. Nailor Industries Inc.
 - c. Price Industries.
 - d. Titus.
 - 2. Devices shall be specifically designed for variable-air-volume flows.
 - 3. Material: Aluminum.
 - 4. Finish: Baked enamel, white.

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 121505 Diffusers, Registers, and Grilles Section 23 3713 - 2

- 5. Narrow Core Spacing Arrangement: 1/8-inch- thick blades spaced 1/4 inch apart, zero degree deflection.
- 6. Wide Core Spacing Arrangement: 1/8-inch- thick blades spaced 1/2 inch apart, zero degree deflection.
- 7. Pencil-Proof Core Spacing Arrangement: 3/16-inch- thick blades spaced 7/16 inch apart, zero degree deflection.
- 8. Two Way Deflection Vanes: Extruded construction fixed louvers with removable core.
- 9. Mounting: Spring clip.
- B. Linear Slot Diffuser:
 - 1. Manufacturers: Subject to compliance with requirements. Provide product indicated on drawings or one of the following:
 - a. METALAIRE, Inc.
 - b. Nailor Industries Inc.
 - c. Price Industries.
 - d. Titus.
 - 2. Material Shell: Aluminum, noninsulated.
 - 3. Material Pattern Controller and Tees: Aluminum.
 - 4. Finish Face and Shell: Baked enamel, black.
 - 5. Finish Pattern Controller: Baked enamel, black.
 - 6. Finish Tees: Baked enamel, white.
- C. Ceiling-Integral Continuous Diffuser:
 - 1. Manufacturers: Subject to compliance with requirements. Provide product indicated on drawings or one of the following:
 - a. METALAIRE, Inc.
 - b. Nailor Industries Inc.
 - c. Price Industries.
 - d. Titus.
 - 2. Straight and curved sections as required to accommodate layout.
 - 3. Mitered tees and corners.
 - 4. Pattern Controllers: 24 inches o.c.
 - 5. Material: Aluminum, extruded, heavy wall.
 - 6. Finishes:
 - a. Exterior: Standard white.
 - b. Interior: Standard black.
 - 7. Other Features:
 - a. Painted interior.
 - b. Blank-offs.

2.3 REGISTERS AND GRILLES

- A. Fixed Face Register:
 - 1. Manufacturers: Subject to compliance with requirements. Provide product indicated on drawings or one of the following:
 - a. Nailor Industries Inc.
 - b. Price Industries.
 - c. Titus.
 - 2. Material: Aluminum.
 - 3. Finish: Baked enamel, white.
 - 4. Face Arrangement: 1/2-by-1/2-by-1/2-inch grid core.
 - 5. Core Construction: Removable.
 - 6. Frame: 1-1/4 inches wide.
 - 7. Mounting: Lay in.
- B. Fixed Face Grille:
 - 1. Manufacturers: Subject to compliance with requirements. Provide product indicated on drawings or one of the following:
 - a. Nailor Industries Inc.
 - b. Price Industries.
 - c. Titus.
 - 2. Material: Aluminum.
 - 3. Finish: Baked enamel, white.
 - 4. Face Arrangement: 1/2-by-1/2-by-1/2-inch grid core.
 - 5. Core Construction: Removable.
 - 6. Frame: 1-1/4 inches wide.
 - 7. Mounting: Lay in.
- C. Linear Bar Grille:
 - 1. Manufacturers: Subject to compliance with requirements. Provide product indicated on drawings or one of the following:
 - a. Nailor Industries Inc.
 - b. Price Industries.
 - c. Titus.
 - 2. Material: Aluminum.
 - 3. Finish: Baked enamel, white.
 - 4. Face Arrangement: 1/2-by-1/2-by-1/2-inch grid core.
 - 5. Frame: 1-1/4 inches wide.
 - 6. Mounting: Lay in.

2.4 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF DOCUMENT 23 3713

SECTION 23 3714 OPERATING ROOM SINGLE LARGE DIFFUSER SYSTEM

PART 1 - GENERAL

1.01 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.02 SUBMITTALS

- A. Shop Drawings including, but not limited to, the following:
 - 1. Manufacturer's name and model number
 - 2. Identification as referenced in the Documents
 - 3. Capacities/ratings
 - 4. Materials of construction
 - 5. Sound ratings
 - 6. Dimensions
 - 7. Finish
 - 8. Color selection charts where applicable
 - 9. Manufacturer's installation instructions
 - 10. All other appropriate data

1.03 DESIGN CRITERIA

- A. Performance data shall be based on tests conducted in accordance with ASHRAE Standard 70-2006.
- B. Screw holes on surface shall be counter sunk to accept recessed type screws.

1.04 WORK INCLUDED

A. The purpose of this specification is to provide a modular diffuser system with integrated LED flush lighting, and integrated structural support that has the capability of accepting operating room equipment boom, surgical light/monitor and imaging equipment loads directly. Internal framing shall be capable of handling the lateral forces of all equipment supports. The system will be installed by the contractor in accordance with the manufacturer's instructions as outlined in the manufacturer's installation manual. Supplier of this modular diffuser system shall be responsible for all costs associated with the engineering, manufacturing, and project coordination of lights, structural boom and equipment supports included within the boundary of this modular system. These costs shall include the fully integrated (factory assembled) supply of the air delivery system, lighting

system, and structural support system as identified above along with the layout and engineering for all electrical wiring, piping, mechanical and support structures within the system. Non-structural diffuser modules are not allowed. These costs also include a set of fully executed and stamped structural engineering calculations on the entire modular system, including all components mentioned above, for the state in which this project will be installed. The structural calculation package shall be delivered to the project team after a "For Record" approval of submittal documents has been signed and returned by an authorized administrator of the project team.

1.05 SYSTEM DESCRIPTION

A. The operating room air supply array shall be a single large diffuser (SLD) system of modular construction consisting of a continuous ceiling grid with an aluminum air frame HEPA (optional) filter grid channel, integrated LED lighting system, integrated boom mounts, guillotine style (room side adjustable) dampers and laminar air diffuser openings. The ceiling grid is required to be able to completely seal off the interstitial space from the room. The diffuser system shall also include a structural steel air delivery duct (SLD) that is an integrated part of the ceiling grid. The steel duct is required to pressurize the system for distribution through each individual supply air opening in the ceiling. The steel duct shall have a powder coating to ensure all exterior and interior surfaces are protected. The system shall also be capable of accepting operating room boom loads directly as part of an engineered and structurally stamped architectural system.

1.06 QUALITY ASSURANCE

- A. Owner's Factory Inspection:
 - 1. The owner or owner's representative shall maintain the right to tour the operating room diffuser system at manufacturer's plants any time that fabrication is being performed on components intended for this project.
 - 2. The owner may exercise the option, giving 24-hour advance notice minimum, to tour the plant and inspect for component assembly, painting, cleaning, or packaging to ensure that quality control is being maintained.

1.07 SUBMITTAL

- A. Submittal shall be by the manufacturer.
- B. Required with the submittal: Detailed information on structural, mechanical, electrical, and other services necessary to evaluate installation requirements.
- C. Required after execution of Contract: Shop drawings shall be submitted within two weeks of purchase order acceptance, and they shall include: complete specifications, descriptive drawings, catalog cuts, and descriptive literature on all components used in the diffuser system, with make, model, dimensions, capacity, weight, and electrical schematics.

1.08 MANUFACTURER CONTACTS

A. Contact manufacturer directly if additional information is required, such as product or material descriptions, layouts, or installation requirements.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Base Bid shall be CleanSuite

2.02 DIFFUSER GRID SYSTEM

- A. Operating Rooms are supplied by HEPA filtered supply air and do not require additional ceiling HEPA filters.
- B. C-Section Rooms are supplied with MERV 14 filtered supply air and DO require HEPA Filters located in the ceiling. HEPA filters shall be room side replaceable.
- C. The grid system shall utilize an LED lighted grid and bottom-load flush powder-coated steel HEPA filtered air frame. HEPA filters (optional), diffusers, guillotine style balancing dampers and blank pans shall be capable of being loaded from the bottom of the system directly into the grid opening. All lighting components shall be accessible from the room side. The system shall incorporate a hinged damper/diffuser assembly capable of being independently opened for cleaning as well as access for (optional) HEPA filter installation. The damper/diffuser shall be room side adjustable. The damper/diffuser assembly shall be located downstream of the (optional) HEPA filter and flush with the ceiling to insure easy balancing of the system with all components installed. The damper/diffuser assembly shall incorporate an Allen Key guide for easy access to the guillotine style damper adjustment mechanism. Systems that utilize balancing dampers located upstream of the HEPA are not permitted.
- D. Grid members shall be formed together into modules. Grid shall be caulked with an appropriate sealant as necessary. The ceiling support grid shall be structurally constructed so as to remain dimensionally stable.
- E. The lighted grid system shall have integrated LED lighting within the grid channel. The interior space within the Lighted Grid channel is not required to be powder coated. The lighted grid shall be integrated into the diffuser system such that the finished elevation of the lighted grid lines up within 1/8" in elevation to the bottom of the HEPA filtered air frame. Light fixtures, such as teardrop lights, are not permitted. Light fixtures that block the airflow within the supply air, such as recessed light troffers, are not permitted. All lighting components shall be pre-installed at the factory. Systems that require field installation of lighting components are not permitted. Lighting circuits shall utilize quick connect fittings for module-to-module connection.
 - 1. The complete lighting system consisting of LED assemblies, drivers, wireway, lenses, and wiring shall be an integral part of the lighted grid. The LED lighted grid shall be UL listed and so marked.
 - 2. The drivers shall be housed within the grid channel and accessible from the room side. Drivers shall be UL listed and so marked. Drivers may be remote mounted in an enclosure attached to the side of the system and accessible through an access panel in the perimeter ceiling.
 - 3. Wiring within the grid for the lighting circuit shall be contained within and protected by the grid system. The system shall have the ability to handle normal and emergency wiring circuits. The system shall have the ability to handle high and low voltage wiring circuits. The light lens shall sit flush with the bottom of the air frame grid channel.

Light lens covers shall be clear acrylic or polycarbonate ribbed diffusers that snap flush to the grid channel without external fasteners.

- 4. LED lighting components shall be able to easily snap into the grid without the use of rivets, nuts, bolts or other hardware fasteners.
- 5. Optional Indigo-Clean[™] LED technology with two operational modes: White Disinfection Mode is a white LED array for ambient lighting plus simultaneous low power 405nm indigo array for low-level continuous environmental disinfection. Indigo Disinfection Mode is a high power 405nm Indigo LED array for continuous environmental disinfection. Operational mode determined via internal low-voltage device based upon input provided by external IC100 room control system. Room controls and control wiring shall be installed in the field by electrical contractor to meet all local codes.
 - a. Serviceable composite-bodied mid-power white LED array and high-power 405 nm indigo LED array.
 - b. Available 3700K and 4300K color temperatures with maximum 3-step MacAdam variation allowance.
 - c. Minimum 80 CRI standard with optional minimum 90 CRI available.
 - d. 120/277VAC, 50/60Hz electrical input with serviceable high-power factor electronic, constant-current drivers (<10% THD, >0.90 PF). Minimum 85% driver efficiency.
 - e. Standard 0-10V dimming with 1-100% range with dim-to-dark capabilities in White Disinfection Mode. 700 µA maximum source current.
- F. The installing contractor shall furnish and install the all thread rod up to and including the connection components at the building structure.
- G. The lighted grid system shall be capable of attaching clips for hanging patient lifts, equipment supports, and other components.
- H. All surfaces that are scratched shall be painted and touched up by the contractor after installation. Paint color to match all surfaces or as approved by the engineer or owner.
- I. Filler Blank Panels: Solid filler panels shall be constructed of powder coated steel or aluminum with welded corners, an upward facing trough and designed to affect an airtight seal in the channel grid. The finish of the panel shall match the ceiling grid finish.
- J. Care should be used in selection of materials that are resistant to cleaning agents used by the owner.

2.03 AIR SUPPLY INTEGRATED TO CEILING GRID

- A. Provide an air delivery duct attached to the ceiling grid as an integral part of the ceiling grid diffuser system. Modules shall be supplied completely pre-assembled with the lighting grid, HEPA filtered air frame and duct as one piece.
- B. The ceiling grid module shall be capable of being suspended from the building structure based on the coordination between the structural engineer of record and the modular

diffuser system manufacturer's structural stamped package. The structural engineer of record shall be responsible for designing the structural connections and related steel infrastructure to support the ceiling system from the building.

- C. Modules will be welded or rivet style construction using steel roof panels welded to HSS framing or steel side panels. System shall be sized so as to meet structural load requirements. Holes will be provided at the perimeter of the module roof for suspension. The entire ceiling grid module shall be coated with a baked-on powder coating.
- D. Units shall be manufactured to dimensional tolerance of +/- 1/8" on width and length and diagonal dimensions or squareness of +/-1/8".
- E. Provide pre-drilled bolt holes in the sides of modules for field connection of one module to another where applicable.
- F. The HSS framed modules shall be capable of accepting operating room boom loads directly as part of an engineered and structurally stamped system.

PART 3 - EXECUTION

3.01 INSTALLATION- GENERAL

A. Install in accordance with the manufacturer's installation manual. The installing contractor shall be responsible for the complete installation of the operating room ceiling system. All repairs and re-testing cost of the repairs and other related tests that would have to be repeated as a result of repairs done to the system shall be the installing contractor's responsibility.

3.02 MODULE INSTALLATION

- A. It is the intent that the modules be installed to line and true level, symmetrical to rooms and spaces, and with due regard to appearance and structural stability. The ceiling shall be level throughout within 1/8 inch.
- B. All suspended ceiling system work shall be done in accordance with the procedures endorsed by the Ceiling and Interior Systems Contractor's Association (CISCA), except where specified otherwise.
- C. Lay out modules as shown on shop drawings. Coordinate with mechanical and electrical equipment in framing and cutting around ceiling penetrations.
- D. Hang level as shown on the drawings in accordance with ASTM C636 and the manufacturer's current printed instructions for the type of installation used.
- E. Modules shall be supported per structural specifications. Modules are butted side to side and end to end and bolted together. A sealant is required at all joints. All field assembly and materials are by contractor unless noted.
- F. Install hanging hardware at specified locations and per manufacturer's instructions.
- G. Install seals per manufacturer's instructions.
- H. Blank pans and associated hold-down clips are to be installed per manufacturer's instructions.

I. Lighting fixtures are to be installed per the ceiling plans. Wiring shall be installed by electrical contractor to meet all local codes.

3.03 MATERIAL PREPARATION, CLEANING AND FINAL CLEANUP

- A. The general cleanliness requirements shall be that all surfaces and hardware exposed to the operating room interior or in the airstream, regardless of size or complexity, must be visibly free of oil, grease, particles, chips, fibers, dirt, etc., prior to installation in the operating room area.
- B. The general cleaning sequence for the units shall be as follows: Visual inspection per above; vacuum removal of particles; solvent wipe cleaning; drying; visual inspection per above.

3.04 CEILING CERTIFICATION

A. At the completion of the ceiling installation, with all components installed and wall systems in place, an independent certifier under a separate contract shall conduct a series of tests to ensure that the operating room complies with owner's specifications.

END OF DOCUMENT 23 3713

SECTION 23 3723 HVAC GRAVITY VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following types of roof-mounting intake and relief ventilators:
 - 1. Louver penthouses.
 - 2. Goosenecks.

1.3 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Intake and relief ventilators shall be capable of withstanding the effects of gravity loads, wind loads, and thermal movements without permanent deformation of components, noise or metal fatigue, or permanent damage to fasteners and anchors.
- B. Water Entrainment: Limit water penetration through unit to comply with ASHRAE 62.1-2004.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. LEED Submittal:
 - 1. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1-2004, Section 5 "Systems and Equipment."
- C. Shop Drawings: For intake and relief ventilators. Include plans, elevations, sections, details, and ventilator attachments to curbs and curb attachments to roof structure.
- D. Coordination Drawings: Roof framing plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Structural members to which roof curbs and ventilators will be attached.
 - 2. Sizes and locations of roof openings.
- E. Samples for Verification: For each type of exposed finish required for intake and relief ventilators.
- F. Welding certificates.
- G. Hurricane-Impact Ratings: Provide submittal of Miami-Dade County Hurricane Impact Testing/NOA Certification.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain ventilators through one source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.
- B. Product Options: Information on Drawings and in Specifications establishes requirements for system's aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.
- C. Product Options: Drawings indicate size, profiles, and dimensional requirements of intake and relief ventilators and are based on the specific equipment indicated. Refer to Division 01 Section "Product Requirements."
 - 1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.
- D. Welding: Qualify procedures and personnel according to the following:
 - 1. AWS D1.2, "Structural Welding Code--Aluminum."
 - 2. AWS D1.3, "Structural Welding Code--Sheet Steel."

1.6 COORDINATION

A. Coordinate installation of roof curbs and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 MATERIALS

- A. Aluminum Extrusions: ASTM B 221, Alloy 6063-T5 or T-52.
- B. Aluminum Sheet: ASTM B 209, Alloy 3003 or 5005 with temper as required for forming or as otherwise recommended by metal producer for required finish.
- C. Galvanized-Steel Sheet: ASTM A 653/A 653M, G90 zinc coating, mill phosphatized.
- D. Stainless-Sheet Sheet: ASTM A 666, Type 304, with No. 4 or 6 finish.

2.3 FABRICATION, GENERAL

- A. Factory or shop fabricate intake and relief ventilators to minimize field splicing and assembly. Disassemble units to the minimum extent as necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.
- B. Fabricate frames, including integral bases, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
- C. Fabricate units with closely fitted joints and exposed connections accurately located and secured.
- D. Fabricate supports, anchorages, and accessories required for complete assembly.
- E. Perform shop welding by AWS-certified procedures and personnel.

2.4 HURRICANE IMPACT RATED LOUVER PENTHOUSES

- A. Manufacturers:
 - 1. Acme Engineering & Mfg. Corp.
 - 2. Ruskin
 - 3. Greenheck
- B. Ruskin Greenheck Construction: All-welded assembly with 6 inch deep louvers, mitered corners, and galvanized steel sheet roof.
- C. Frame and Blade Material and Nominal Thickness: Extruded aluminum, of thickness required to comply with structural performance requirements, but not less than 0.080 inch for frames and 0.080 inch for blades.
- D. Frame and Blade Material and Nominal Thickness: Galvanized-steel sheet, of thickness required to comply with structural performance requirements, but not less than 0.052 inch for frames and 0.064 inch for blades.
- E. Frame and Blade Material and Nominal Thickness: Stainless-steel sheet, of thickness required to comply with structural performance requirements, but not less than 0.062 inch with grain running parallel to length of blades and frame members. Louver blades shall be capable of withstanding a wind driven rain.
 - 1. Blade spacing: 3".
 - 2. Blade angle: 45°
 - 3. Air Performance: Not more than 0.10-inch wg static pressure drop at 800-fpm freearea velocity
 - 4. AMCA Seal: Mark units with the AMCA Certified Ratings Seal.
 - 5. Exterior Corners: Prefabricated corner units with mitered blades with concealed close-fitting splices and with fully recessed mullions at corners.

2.5 ROOF HOODS – HURRICANE IMPACT RATED

- A. Manufacturers:
 - 1. Ruskin.

- 2. Greenheck.
- B. Factory or shop fabricate according to SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Figures 5-6 and 5-7.
- C. Materials: Galvanized-steel sheet, minimum 0.064-inch- thick base and 0.040-inch- thick hood; suitably reinforced.
- D. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; 1-1/2-inch- thick, rigid fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to fit roof opening and ventilator base, and to allow 36" minimum above roof to bottom of louver.
 - 1. Configuration: Built-in raised cant and mounting flange.
 - 2. Overall Height: 18 inches.
- E. Bird Screening: Stainless-steel, 1/2-inch- square mesh, 0.047-inch wire.
- F. Galvanized Steel Sheet Finish:
 - 1. Surface Preparation: Clean surfaces of dirt, grease, and other contaminants. Clean welds, mechanical connections, and abraded areas and repair galvanizing according to ASTM A 780. Apply a conversion coating suited to the organic coating to be applied over it.
 - 2. Factory Priming for Field Painted Finish: Where field painting after installation is indicated, apply an air dried primer immediately after cleaning and pretreating.

2.6 GOOSENECKS

- A. Factory or shop fabricate according to SMACNA's "HVAC Duct Construction Standards -Metal and Flexible," Figure 5-5; with a minimum of 0.052-inch- thick, galvanized-steel sheet.
- B. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; 1-1/2-inch- thick, rigid fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to fit roof opening and ventilator base.
 - 1. Configuration: Built-in raised cant and mounting flange.
 - 2. Overall Height: 36 inches.
- C. Bird Screening: Aluminum, ½ inch square mesh, 0.063 inch wire.
- D. Galvanized-Steel Sheet Finish:
 - 1. Surface Preparation: Clean surfaces of dirt, grease, and other contaminants. Clean welds, mechanical connections, and abraded areas and repair galvanizing according to ASTM A 780. Apply a conversion coating suited to the organic coating to be applied over it.
 - 2. Factory Priming for Field Painted Finish: Where field painting after installation is indicated, apply an air dried primer immediately after cleaning and pretreating.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install intake and relief ventilators level, plumb, and at indicated alignment with adjacent work.
- B. Secure intake and relief ventilators to roof curbs with cadmium-plated hardware. Use concealed anchorages where possible. Refer to Division 07 Section "Roof Accessories" for installation of roof curbs.
- C. Install goosenecks on curb base where throat size exceeds 9 by 9 inches.
- D. Install intake and relief ventilators with clearances for service and maintenance.
- E. Install perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- F. Install concealed gaskets, flashings, joint fillers, and insulation as installation progresses. Comply with Division 07 Section "Joint Sealants" for sealants applied during installation.
- G. Label intake and relief ventilators according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."
- H. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.
- I. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories.

3.3 ADJUSTING

A. Adjust damper linkages for proper damper operation.

END OF SECTION 23 3723

SECTION 23 4100 PARTICULATE AIR FILTRATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Flat panel filters.
 - 2. Pleated panel filters.
 - 3. Rigid cell box filters.
 - 4. Front- and rear-access filter frames.
 - 5. Side-service housings.
 - 6. Filter gages.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.
- B. Shop Drawings: For air filters. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Show filter rack assembly, dimensions, materials, and methods of assembly of components.
 - 2. Include setting drawings, templates, and requirements for installing anchor bolts and anchorages.
 - 3. Wiring Diagrams: For power, signal, and control wiring.
- C. Operation and Maintenance Data: For each type of filter and rack to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Media-type and electrostatic-type air filters shall be listed and labeled. Media-type air filters shall comply with UL 900.
- C. ASHRAE Compliance:

- Comply with applicable requirements in ASHRAE 62.1, Section 4 "Outdoor Air Quality"; Section 5 - "Systems and Equipment"; and Section 7 - "Construction and Startup."
- 2. Comply with ASHRAE 52.1 for arrestance and ASHRAE 52.2 for MERV for methods of testing and rating air-filter units.
- D. Comply with NFPA 90A and NFPA 90B.

1.5 COORDINATION

A. Coordinate sizes and locations of concrete bases. Cast anchor-bolt inserts into bases.

1.6 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Provide one complete set(s) of filters for each filter bank. If system includes prefilters, provide only prefilters.

PART 2 - PRODUCTS

2.1 FLAT PANEL FILTERS

- A. Description: Factory-fabricated, self-supported, flat, nonpleated, panel-type, disposable air filters with holding frames.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AAF International.
 - b. Camfil Farr.
 - c. Flanders-Precisionaire.
 - d. Air Guard
- B. Filter Unit Class: UL 900, Class 1.
- C. Media: Cotton and synthetic fibers coated with nonflammable adhesive:
 - 1. Adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Media shall be coated with an antimicrobial agent.
 - 3. Metal Retainer: Upstream side and downstream side.
- D. Filter-Media Frame: Cardboard with perforated metal retainer sealed or bonded to the media.
- E. Mounting Frames: Welded galvanized steel, with gaskets and fasteners; suitable for bolting together into built-up filter banks.

2.2 PLEATED PANEL FILTERS
- A. Description: Factory-fabricated, self-supported, extended-surface, pleated, panel-type, disposable air filters with holding frames.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AAF International.
 - b. Camfil Farr.
 - c. Flanders-Precisionaire.
 - d. Air Guard
- B. Filter Unit Class: UL 900, Class 1.
- C. Media: Cotton and synthetic fibers coated with nonflammable adhesive.
 - 1. Adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Media shall be coated with an antimicrobial agent.
 - 3. Separators shall be bonded to the media to maintain pleat configuration.
 - 4. Welded wire grid shall be on downstream side to maintain pleat.
 - 5. Media shall be bonded to frame to prevent air bypass.
 - 6. Support members on upstream and downstream sides to maintain pleat spacing.
- D. Filter-Media Frame: Cardboard frame with perforated metal retainer sealed or bonded to the media.
- E. Mounting Frames: Welded galvanized steel, with gaskets and fasteners; suitable for bolting together into built-up filter banks.

2.3 RIGID CELL BOX FILTERS

- A. Description: Factory-fabricated, adhesive-coated, disposable, packaged air filters with media perpendicular to airflow, and with holding frames.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AAF International.
 - b. Camfil Farr.
 - c. Flanders-Precisionaire.
 - d. Air Guard
- B. Filter Unit Class: UL 900, Class 1.
- C. Media: Fibrous material constructed so individual pleats are maintained in tapered form under rated-airflow conditions by flexible internal supports.
 - 1. Adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Media shall be coated with an antimicrobial agent.
- D. Filter-Media Frames: Galvanized steel.

E. Mounting Frames: Welded galvanized steel, with gaskets and fasteners; suitable for bolting together into built-up filter banks.

2.4 FRONT- AND REAR-ACCESS FILTER FRAMES

- A. Framing System: Galvanized-steel framing members with access for either upstream (front) or downstream (rear) filter servicing, cut to size and prepunched for assembly into modules. Vertically support filters to prevent deflection of horizontal members without interfering with either filter installation or operation.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AAF International.
 - b. Camfil Farr.
 - c. Flanders-Precisionaire.
- B. Prefilters: Incorporate a separate track with spring clips, removable from front.
- C. Sealing: Factory-installed, positive-sealing device for each row of filters, to ensure seal between gasketed filter elements and to prevent bypass of unfiltered air.

2.5 SIDE-SERVICE HOUSINGS

- A. Description: Factory-assembled, side-service housings, constructed of galvanized steel with flanges to connect to duct or casing system.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AAF International.
 - b. Camfil Farr.
 - c. Flanders-Precisionaire.
- B. Prefilters: Integral tracks to accommodate 2-inch- deep, disposable filters.
- C. Access Doors: Hinged, with continuous gaskets on perimeter and positive-locking devices, and arranged so filter cartridges can be loaded from either access door.
- D. Sealing: Incorporate positive-sealing gasket material on channels to seal top and bottom of filter cartridge frames and to prevent bypass of unfiltered air.

2.6 FILTER DIFFERENTIAL PRESSURE GAGE

- A. Differential pressure Diaphragm-type gage with dial and pointer in metal case, vent valves, black figures on white background, and front recalibration adjustment.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Dwyer Instruments, Inc. Minihelic
 - 2. Diameter: 2.5 " Dial Combination Differential Pressure Gauge for Air or Non-Combustible, Non-Corrosive Gas

Accuracy: ±2% Range Single Scale, Range: 0-2.0" H2O

- 3. Scale Range for Filter Media Having a Recommended Final Resistance of 0.5- to 1.0-Inch wg or Less: 0- to 1.0-inch wg.
- 4. Scale Range for Filter Media Having a Recommended Final Resistance of 1.0- to 2.0-Inch wg or Less: 0- to 2.0-inch wg.
- B. Accessories: Static-pressure tips, tubing, gage connections, and mounting bracket.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.
- B. Install filters in position to prevent passage of unfiltered air.
- C. Install filter gage for each filter bank.
- D. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.
- E. Install filter-gage, static-pressure taps upstream and downstream from filters. Install filter gages on filter banks with separate static-pressure taps upstream and downstream from filters. Mount filter gages on outside of filter housing or filter plenum in an accessible position. Adjust and level inclined gages.
- F. Coordinate filter installations with duct and air-handling-unit installations.

3.2 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. Operate automatic roll filters to demonstrate compliance with requirements.
 - 2. Test for leakage of unfiltered air while system is operating.
- D. Air filter will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.3 CLEANING

A. After completing system installation and testing, adjusting, and balancing of air-handling and air-distribution systems, clean filter housings and install new filter media.

END OF SECTION 23 4100

SECTION 23 4133 HIGH EFFICIENCY PARTICULATE FILTRATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. HEPA rigid-cell box filters.
 - 2. HEPA filter diffusers.
 - 3. HEPA filter fan modules.
 - 4. ULPA filters.
 - 5. 95 percent DOP filters.
 - 6. Front- and rear-access filter frames.
 - 7. Side-service housings.
 - 8. Filter gages.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.
- B. Shop Drawings: For air filters. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Show filter rack assembly, dimensions, materials, and methods of assembly of components.
 - 2. Include setting drawings, templates, and requirements for installing anchor bolts and anchorages.
 - 3. Wiring Diagrams: For power, signal, and control wiring.
- C. Field quality-control reports.
- D. Operation and Maintenance Data: For each type of filter and rack to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended use.
- B. ASHRAE Compliance:
 - 1. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
- C. Comply with IEST-RP-CC001.3.

- D. Comply with UL 586.
- E. Comply with IEST-RP-CC007.1.
- F. Comply with NFPA 90A and NFPA 90B.
- 1.5 Media-type air filters shall be listed and labeled. Media-type air filters shall comply with UL 900. High efficiency particulate air filters shall comply with UL 586.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

1.7 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Provide one complete set(s) of filters for each filter bank. If system includes prefilters, provide only prefilters.
 - 2. Provide one container(s) of red oil for inclined manometer filter gage.

PART 2 - PRODUCTS

2.1 HEPA RIGID-CELL BOX FILTERS

- A. Description: Factory-fabricated, disposable, packaged air filters with media perpendicular to airflow and with holding frames.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AAF International.
 - b. Camfil Farr Co.
 - c. Flanders-Precisionaire.
- B. Filter Unit Class: UL 900, Class 1.
- C. Media: Fibrous material, constructed so individual pleats are maintained under ratedairflow conditions.
 - 1. Internal Separators: Aluminum in media folds.
 - 2. Gasket Material: Neoprene.
 - 3. Gasket Location: Upstream and Downstream.
 - 4. Faceguard Material: Aluminum.
 - 5. Faceguard Location: Upstream and Downstream.
- D. Filter-Media Frames:
 - 1. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
 - 2. Materials: Galvanized sheet.
 - 3. Style: Double-turned flange.

E. Mounting Frames: Welded galvanized steel with gaskets and fasteners; suitable for bolting together into built-up filter banks.

2.2 HEPA FILTER DIFFUSERS

- A. Description: Factory-fabricated, individually ducted, HEPA filter-holding ceiling modules.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. AAF International.
 - b. Camfil Farr Co.
 - c. Flanders-Precisionaire.
- B. Media: Fibrous glass, constructed of continuous sheets with closely spaced pleats with glass filament separators.
 - 1. Media to Module Side Bond: Urethane sealant.
 - 2. Media to Frame Side Bond: Silicone.
 - 3. Application: Class 1 clean room.
- C. Casing:
 - 1. Configuration: Ducted inlet.
 - 2. Module Material: Extruded aluminum, 16 gage with mill finish.
 - 3. Suspension: Ceiling grid.
- D. Accessories:
 - 1. Diffusion damper.
 - 2. Diffusion-damper adjustment port.
 - 3. Filter test port.

2.3 ULPA FILTERS

- A. Description: Factory-fabricated, ULPA filters with holding casing.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AAF International.
 - b. Camfil Farr Co.
 - c. Flanders-Precisionaire.
- B. Media: Fibrous glass, constructed of continuous sheets with closely spaced pleats with aluminum separators.
- C. Frame Material: Galvanized steel.
- D. Media to Frame Side Bond: Silicone.
- E. Face Gasket: Neoprene expanded rubber.

F. Mounting Frames: Construct downstream corners of holding device with cushion pads to protect media. Provide bolted filter-sealing mechanism to mount and continuously seal each individual filter.

2.4 95 PERCENT DOP FILTERS

- A. Description: Factory-fabricated, 95 percent DOP filters with holding casing.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AAF International.
 - b. Camfil Farr Co.
 - c. Flanders-Precisionaire.
- B. Media: Fibrous glass, constructed of continuous sheets with closely spaced pleats with aluminum separators.
- C. Frame Material: Galvanized steel.
- D. Frame Style: Double turned flange.
- E. Media to Frame Side Bond: Silicone.
- F. Face Guard Material: Galvanized mesh.
- G. Face Guard Location: Upstream.
- H. Gasket Material: Neoprene expanded rubber.
- I. Gasket Location: Upstream and Downstream.
- J. Mounting Frames: Construct downstream corners of holding device with cushion pads to protect media. Provide bolted filter-sealing mechanism to mount and continuously seal each individual filter.

2.5 FRONT- AND REAR-ACCESS FILTER FRAMES

- A. Framing System: Aluminum framing members with access for either upstream (front) or downstream (rear) filter servicing, cut to size and prepunched for assembly into modules. Vertically support filters to prevent deflection of horizontal members without interfering with either filter installation or operation.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AAF International.
 - b. Camfil Farr Co.
 - c. Flanders-Precisionaire.
- B. Prefilters: Incorporate a separate track, removable from front or back.
- C. Sealing: Factory-installed, positive-sealing device for each row of filters to ensure seal between gasketed filter elements to prevent bypass of unfiltered air.

D. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

2.6 SIDE-SERVICE HOUSINGS

- A. Description: Factory-assembled, side-service housings, constructed of 0.064-inch- thick, galvanized steel to hold filters. Side servicing is through gasketed access doors on one side, and housings are capable of connection to other housings. Equip housings with metal slide channel tracks with clamping mechanisms to hold filters, and the following:
 - 1. Pressure tap and fitting.
 - 2. DOP/freon test ports.
 - 3. Decontamination ports.
 - 4. Isolation dampers.
 - 5. Lifting lugs.
 - 6. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AAF International.
 - b. Camfil Farr Co.
 - c. Flanders-Precisionaire.
- B. Prefilters: Integral tracks to accommodate 2-, 4-, and 6-inch- thick, disposable filters.
- C. Access Doors: Continuous gaskets on perimeter and positive-locking swivel devices. Arrange so filter cartridges can be loaded from an access door for each tier and section of the following:
 - 1. Combination prefilter and HEPA filter.
 - 2. Prefilter.
 - 3. HEPA filter.
 - 4. Upstream and downstream test section.
- D. Sealing: Incorporate positive-sealing gasket material on channels to seal top and bottom of filter cartridge frames to prevent bypass of unfiltered air.
- E. Accessories:
 - 1. Filter change-out trays.
 - 2. Document-storage pocket.
 - 3. Filter removal rod.
- F. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

2.7 FILTER DIFFERENTIAL PRESSURE GAGE/SWITCH

- A. Combination Differential pressure Diaphragm-type gage/switch with dial and pointer in metal case, vent valves, black figures on white background, and front recalibration adjustment.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Dwyer Instruments, Inc. Photohelic.

- Diameter: 4 " Dial Combination Differential Pressure Switch and Pressure Gauge or Air or Non-Combustible, Non-Corrosive Gas Accuracy: ±2% Range Single Scale, Range: 0-2.0" H2O
- 3. Two SPDT Relay Contacts, Gold Over Silver. Suitable for Dry Circuits. Rated 1 Amp at 30 VDC, 0.3 Amp at 110 VDC, or 0.5 Amp at 125 VAC Resistive Load.
- 4. Scale Range for Filter Media Having a Recommended Final Resistance of 0.5- to 1.0-Inch wg or Less: 0- to 1.0-inch wg.
- 5. Scale Range for Filter Media Having a Recommended Final Resistance of 1.0- to 2.0-Inch wg or Less: 0- to 2.0-inch wg.
- B. Accessories: Static-pressure tips, tubing, gage connections, and mounting bracket.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.
- B. Install filters in position to prevent passage of unfiltered air.
- C. Install filter gage for each filter bank.
- D. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters that were used during construction and testing with new, clean filters.
- E. Install filter-gage static-pressure tips upstream and downstream from filters. Install filter gages on filter banks with separate static-pressure taps upstream and downstream from filters. Mount filter gages on outside of filter housing or filter plenum in an accessible position. Adjust and level inclined gages.
- F. Coordinate filter installations with duct and air-handling unit installations.

3.2 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installation, including connections.
- B. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. Operate automatic roll filters to demonstrate compliance with requirements.
 - 2. Test for leakage of unfiltered air while system is operating.

- 3. HEPA Filters: Pressurize housing to a minimum of 3.0-inch wg or to designed operating pressure, whichever is higher; test housing joints, door seals, and sealing edges of filter with soapy water to check for air leaks.
- 4. HEPA Filters: Pressurize housing to a minimum of 3.0-inch wg or to designed operating pressure, whichever is higher; and test housing joints, door seals, and sealing edges of filter for air leaks according to pressure-decay method in ASME N510.
- D. Air filter will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.3 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling and air-distribution systems, clean filter housings and install new filter media.

END OF SECTION 23 4133

SECTION 23 5216 CONDENSING BOILERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes packaged, factory-fabricated and -assembled, gas-fired, fire-tube condensing boilers, trim, and accessories for generating hot water.

1.3 SUBMITTALS

- A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.
- E. Warranty: Special warranty specified in this Section.
- F. Other Informational Submittals:

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.
- C. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."
- D. UL Compliance: Test boilers for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

1.5 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Fire-Tube Condensing Boilers:
 - a. Leakage and Materials: 10 years from date of Substantial Completion.
 - b. Heat Exchanger Damaged by Thermal Stress and Corrosion: Nonprorated for five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - 1. AERCO International, Benchmark BMK-3.0LN
 - 2. Patterson-Kelly MACH C2500
 - 3. PVI Power VTX

2.2 MANUFACTURED UNITS

- A. Description: Factory-fabricated, -assembled, and -tested, fire-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Water heating service only.
- B. Heat Exchanger: Nonferrous, corrosion-resistant combustion chamber.
- C. Pressure Vessel: Carbon steel with welded heads and tube connections.
- D. Burner: Propane gas, forced draft.
- E. Blower: Centrifugal fan to operate during each burner firing sequence and to prepurge and postpurge the combustion chamber.
 - 1. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 - a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- F. Gas Train: Combination gas valve with manual shutoff and pressure regulator.
- G. Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision.
- H. Casing:
 - 1. Jacket: Sheet metal, with snap-in or interlocking closures.
 - 2. Control Compartment Enclosures: NEMA 250, Type 1A.
 - 3. Finish: Baked-enamel protective finish.

- 4. Insulation: Minimum 2-inch- thick, mineral-fiber insulation surrounding the heat exchanger.
- 5. Combustion-Air Connections: Inlet and vent duct collars.
- 6. Mounting base to secure boiler.

2.3 TRIM

- A. Aquastat Controllers: Operating, firing rate and high limit.
- B. Safety Relief Valve: ASME rated.
- C. Pressure and Temperature Gage: Minimum 3-1/2-inch- diameter, combination waterpressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges so normal operating range is about 50 percent of full range.
- D. Boiler Air Vent: Automatic.
- E. Drain Valve: Minimum NPS 3/4 hose-end gate valve.

2.4 CONTROLS

- A. Boiler operating controls shall include the following devices and features:
 - 1. Control transformer.
 - 2. Boiler Master Control Panel.
 - 1) This panel shall interface with the boilers standalone control panel and provide by the boiler vendor.
 - 2) This panel shall be able to communicate with the fuel oil system monitoring/control panel. This is to control the operation of the fuel oil pumps at the tanks.
 - 3. Set-Point Adjust: Set points shall be adjustable.
 - 4. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to reset supply-water temperature inversely with outside-air temperature. At 0 deg F outside-air temperature, set supply-water temperature at 200 deg F; at 60 deg F outside-air temperature, set supply-water temperature at 140 deg F.
 - a. Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.
- B. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.
 - 1. High Cutoff: Automatic reset stops burner if operating conditions rise above maximum boiler design temperature.
 - 2. Low-Water Cutoff Switch: Float and electronic probe shall prevent burner operation on low water. Cutoff switch shall be manual reset type.

- 3. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.
- C. Building Control System Interface: Factory install hardware and software to enable building automation system to monitor, control, and display boiler status and alarms.
 - 1. Hardwired Points:
 - a. Monitoring: On/off status, common trouble alarm, low water level alarm.
 - b. Control: On/off operation, hot water supply temperature set-point adjustment.
 - A communication interface with Building Control System in Section 23 0900 shall enable the operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through the Building Control System using BACNet MS/TP or TCP/IP communications network compatible with the Building Control System.

2.5 ELECTRICAL POWER

- A. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
 - 1. House in NEMA 250, Type 1 enclosure.
 - 2. Wiring shall be numbered and color-coded to match wiring diagram.
 - 3. Install factory wiring outside of an enclosure in a metal raceway.
 - 4. Field power interface shall be to wire lugs.
 - 5. Provide branch power circuit to each motor and to controls with a disconnect switch or circuit breaker.
 - 6. Provide each motor with overcurrent protection.

2.6 SOURCE QUALITY CONTROL

- A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
- B. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.
- C. Allow Owner access to source quality-control testing of boilers. Notify Architect 14 days in advance of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.

- 1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- B. Examine mechanical spaces for suitable conditions where boilers will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BOILER INSTALLATION

- A. Install boilers level on concrete base. Concrete base is specified in Division 23 Section "Common Work Results for HVAC," and concrete materials and installation requirements are specified in Division 03.
- B. Vibration Isolation: Elastomeric isolation pads with a minimum static deflection of 0.25 inch. Vibration isolation devices and installation requirements are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- C. Install gas-fired boilers according to NFPA 54.
- D. Assemble and install boiler trim.
- E. Install electrical devices furnished with boiler but not specified to be factory mounted.
- F. Install control wiring to field-mounted electrical devices.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to boiler to allow service and maintenance.
- C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.
- D. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Division 23 Section "Common Work Results for HVAC."
- E. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.
- F. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.
- G. Install piping from safety relief valves to nearest floor drain.
- H. Install piping from safety valves to drip-pan elbow and to nearest floor drain.
- I. Boiler Venting:
 - 1. Connect full size to boiler connections. Comply with requirements in Manufacturer's Recommendations.

- J. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- K. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Perform installation and startup checks according to manufacturer's written instructions.
 - 2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
 - b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.
- E. Performance Tests:
 - 1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
 - 2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
 - 3. Perform field performance tests to determine capacity and efficiency of boilers.
 - a. Test for full capacity.
 - b. Test for boiler efficiency at low fire 20, 40, 60, 80, 100, 80, 60, 40, and 20 percent of full capacity. Determine efficiency at each test point.
 - 4. Repeat tests until results comply with requirements indicated.

- 5. Provide analysis equipment required to determine performance.
- 6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.
- 7. Notify Architect in advance of test dates.
- 8. Document test results in a report and submit to Architect.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain boilers. Refer to Division 01 Section "Demonstration and Training."

END OF DOCUMENT 23 5216

SECTION 23 6416 CENTRIFUGAL WATER CHILLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Packaged, water-cooled, electric-motor-driven centrifugal chillers.

1.3 DEFINITIONS

- A. Retain definition(s) remaining after this Section has been edited.
- B. BAS: Building automation system.
- C. IPLV: Integrated part-load value. A single-number part-load efficiency figure of merit calculated per the method defined by ARI 550/590 and referenced to ARI standard rating conditions.
- D. NPLV: Nonstandard part-load value. A single-number part-load efficiency figure of merit calculated per the method defined by ARI 550/590 and intended for operating conditions other than the ARI standard rating conditions.

1.4 PERFORMANCE REQUIREMENTS

- A. Condenser-Fluid Temperature Performance:
 - 1. Startup Condenser-Fluid Temperature: Chiller shall be capable of starting with an entering condenser-fluid temperature of 60 deg F and providing stable operation until the system temperature is elevated to the minimum operating entering condenser-fluid temperature.
 - 2. Minimum Operating Condenser-Fluid Temperature: Chiller shall be capable of continuous operation over the entire capacity range indicated with an entering condenser-fluid temperature of 60 deg F.
 - 3. Make factory modifications to standard chiller design if necessary to comply with performance indicated.
- B. Site Altitude: Chiller shall be suitable for altitude at which installed without affecting performance indicated. Make adjustments to affected chiller components to account for site altitude.
- C. Performance Tolerance: The chiller shall be certified in accordance with ARI standard 550/590.

1.5 SUBMITTALS

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 121505 Centrifugal Water Chillers Section 23 6416 - 1

- A. Product Data: For each type of product indicated. Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.
 - 1. Performance at ARI standard conditions and at conditions indicated.
 - 2. Performance at ARI standard unloading conditions.
 - 3. Minimum evaporator flow rate.
 - 4. Refrigerant capacity of chiller.
 - 5. Oil capacity of chiller.
 - 6. Fluid capacity of evaporator, condenser.
 - 7. Characteristics of safety relief valves.
 - 8. Minimum entering condenser-fluid temperature.
 - Performance at varying capacities with constant design condenser-fluid temperature. Repeat performance at varying capacities for different condenser-fluid temperatures from design to minimum in 5 deg F increments.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, load distribution, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.
- C. Coordination Drawings: Floor plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Structural supports.
 - 2. Piping roughing-in requirements.
 - 3. Wiring roughing-in requirements, including spaces reserved for electrical equipment.
 - 4. Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.
- D. Certificates: For certification required in "Quality Assurance" Article.
- E. Source quality-control reports.
- F. Startup service reports.
- G. Operation and Maintenance Data: For each chiller to include in emergency, operation, and maintenance manuals.
- H. Warranty: Sample of special warranty.

1.6 QUALITY ASSURANCE

- A. ARI Certification: Certify chiller according to ARI 550 certification program.
- B. ARI Rating: Rate chiller performance according to requirements in ARI 550/590.
- C. ASHRAE Compliance:
 - 1. ASHRAE 15 for safety code for mechanical refrigeration.
 - 2. ASHRAE 147 for refrigerant leaks, recovery, and handling and storage requirements.

- D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1
- E. ASME Compliance: Fabricate and label chillers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, as applicable to chiller design. For chillers charged with R-134a refrigerant, include an ASME U-stamp and nameplate certifying compliance.
- F. Comply with NFPA 70.
- G. Comply with requirements of UL and UL Canada, and include label by a qualified testing agency showing compliance.
- H. Green Seal Compliance: Signed by manufacturer certifying compliance with GS-31.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Charge each chiller with nitrogen if refrigerant is shipped in containers separate from chiller.
 - 1. Ship oil in containers separate from chiller.
- B. Package chiller for export shipping in totally enclosed bagging.

1.8 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.
- B. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of chillers that fails in materials or workmanship within specified warranty period.
 - 1. Extended warranties include, but are not limited to, the following:
 - a. Complete chiller including refrigerant and oil charge.
 - b. Complete compressor and drive assembly including refrigerant and oil charge.
 - c. Refrigerant and oil charge.
 - d. Parts and labor.
 - e. Loss of refrigerant charge for any reason.
 - 2. Warranty Period: 120 months from unit start-up or 126 months from unit shipment whatever occurs first

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements:
 - 1. Trane; a division of American Standard.

2.2 MANUFACTURED UNIT

A. Description: Factory-assembled and -tested chiller complete with compressor, compressor motor, compressor motor controller, lubrication system evaporator, condenser, controls, interconnecting unit piping and wiring, and indicated accessories.

2.3 COMPRESSOR-DRIVE ASSEMBLY

- A. Description: Single-stage or multistage, variable-displacement, centrifugal-type compressor driven by an electric motor.
- B. Compressor:
 - 1. Casing: Cast iron, precision ground.
 - 2. Impeller: High-strength cast aluminum or cast-aluminum alloy on carbon- or alloysteel shaft.
- C. Drive: Direct-hermetic design using an electric motor as the driver.
- D. Compressor Motor:
 - 1. Continuous-duty, squirrel-cage, induction-type, two-pole motor with energy efficiency required to suit chiller energy efficiency indicated.
 - 2. Factory mounted, aligned, and balanced as part of compressor assembly before shipping.
 - 3. Motor shall be of sufficient capacity to drive compressor throughout entire operating range without overload and with sufficient capacity to start and accelerate compressor without damage.
 - 4. Provide motor with thermistor or RTD in each of three-phase motor windings to monitor temperature and report information to chiller control panel.
 - 5. Provide motor with thermistor or RTD to monitor bearing temperature and report information to chiller control panel.
- E. Vibration Balance: Balance chiller compressor and drive assembly to provide a precision balance that is free of noticeable vibration over the entire operating range.
 - 1. Overspeed Test: 25 percent above design operating speed.

- F. Service: Easily accessible for inspection and service.
 - 1. Compressor's internal components shall be accessible without having to remove compressor-drive assembly from chiller.
 - 2. Provide lifting lugs or eyebolts attached to casing.
- G. Economizers: For multistage chillers, provide interstage economizers.
- H. Capacity Control: Modulating, variable-inlet, guide-vane assembly
 - 1. Maintain stable operation that is free of surge, cavitation, and vibration throughout range of operation. Configure to achieve most energy-efficient operation possible.
 - 2. Operating Range: From 100 to 15 percent of design capacity.
 - 3. Condenser-Fluid Unloading Requirements over Operating Range: Constant-design entering condenser-fluid temperature.
- I. Oil Lubrication System: Consisting of pump, filtration, heater, cooler, factory-wired power connection, and controls.
 - 1. Provide lubrication to bearings, gears, and other rotating surfaces at all operating, startup, coastdown, and standby conditions including power failure.
 - 2. Manufacturer's standard method to remove refrigerant from oil.
 - 3. Oil filer, 0.5-micron efficiency, with means of positive isolation while servicing.
 - 4. Refrigerant- or water-cooled oil cooler.
 - 5. Factory-installed and pressure-tested piping with isolation valves and accessories.
 - 6. Oil compatible with refrigerant and chiller components.
 - 7. Positive visual indication of oil level.

2.4 **REFRIGERATION**

- A. Refrigerant:
 - 1. Type: R-123; ASHRAE 34, Class A1 or Class B1.
 - 2. Compatibility: Chiller parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
- B. Refrigerant Flow Control: Manufacturer's standard refrigerant flow-control device satisfying performance requirements indicated.
- C. Pressure Relief Device:
 - 1. Comply with requirements in ASHRAE 15 and in applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

- 2. For Chillers Using R-123: Spring-loaded, pressure relief valve; single- or multiplereseating type.
- D. Refrigeration Transfer: Provide service valves and other factory-installed accessories required to facilitate transfer of refrigerant from chiller to a remote refrigerant storage and recycling system. Comply with requirements in ASHRAE 15 and ASHRAE 147.
- E. Refrigerant Isolation for Chillers Using R-134a: Factory install positive shutoff, manual isolation valves in the compressor discharge line to the condenser and the refrigerant liquid line leaving the condenser to allow for isolation and storage of full refrigerant charge in the chiller condenser shell. In addition, provide isolation valve on suction side of compressor from evaporator to allow for isolation and storage of full refrigerant charge in the chiller evaporator shell.
- F. Purge System:
 - 1. For chillers operating at subatmospheric pressures (using R-123 refrigerant), factory install an automatic purge system for collection and return of refrigerant and lubricating oil and for removal of noncondensables including, but not limited to, water, water vapor, and noncondensable gases.
 - 2. System shall be a thermal purge design, refrigerant or air cooled, equipped with a carbon filter that includes an automatic regeneration cycle.
 - 3. Factory wire to chiller's main power supply and system complete with controls, piping, and refrigerant valves to isolate the purge system from the chiller.
 - 4. Construct components of noncorrodible materials.
 - 5. Controls shall interface with chiller control panel to indicate modes of operation, set points, data reports, diagnostics, and alarms.
 - 6. Efficiency of not more than 0.02 lb of refrigerant per pound of air when rated according to ARI 580.
 - 7. Operation independent of chiller per ASHRAE 147.

2.5 EVAPORATOR

- A. Description: Shell-and-tube design with water in tubes and refrigerant surrounding tubes within shell. Shell is separate from condenser.
- B. Shell Material: Carbon-steel rolled plates with continuously welded seams or seamless pipe.
- C. Designed to prevent liquid refrigerant carryover from entering compressor.
- D. Tubes:
 - 1. Individually replaceable from either end and without damage to tube sheets and other tubes.
 - 2. Mechanically expanded into end sheets and physically attached to intermediate tube sheets.
 - 3. Material: Copper.
 - 4. Nominal OD: 3/4 or 1 inch.

- 5. Minimum Wall Thickness External Finish: Manufacturer's standard.
- 6. Internal Finish: Enhanced.
- E. End Tube Sheets: Continuously welded to each end of shell; drilled and reamed to accommodate tubes with positive seal between fluid in tubes and refrigerant in shell.
- F. Intermediate Tube Sheets: Installed in shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear.
- G. Water Box:
 - 1. Cast-iron or carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
 - 2. Standard type for water box with piping connections. Standard type for water box without piping connections.
 - 3. Provide water boxes with lifting lugs or eyebolts.
 - 4. Hinged marine water-box covers.
 - 5. Nozzle Pipe Connections: Grooved with mechanical-joint coupling
 - 6. Thermistor or RTD temperature sensor factory installed in each nozzle.
 - 7. Fit each water box with 3/4- or 1-inch drain connection at low point and vent connection at high point, each with threaded plug.
- H. Additional Corrosion Protection:
 - 1. Electrolytic corrosion-inhibitor anode.

2.6 CONDENSER

- A. Description: Shell-and-tube design with water in tubes and refrigerant surrounding tubes within shell. Shell is separate from evaporator.
- B. Shell Material: Carbon-steel rolled plates with continuously welded seams or seamless pipe.
- C. Designed to prevent direct impingement of high-velocity hot gas from compressor discharge on tubes.
- D. Tubes:
 - 1. Individually replaceable from either end and without damage to tube sheets and other tubes.
 - 2. Mechanically expanded into end sheets and physically attached to intermediate tube sheets.
 - 3. Material: Copper.
 - 4. Nominal OD: 3/4 or 1 inch.
 - 5. Minimum Wall
 - 6. External Finish: Manufacturer's standard.
 - 7. Internal Finish: Enhanced.
- E. End Tube Sheets: Continuously welded to each end of shell; drilled and reamed to accommodate tubes with positive seal between fluid in tubes and refrigerant in shell.

- F. Intermediate Tube Sheets: Installed in shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear.
- G. Water Box:
 - 1. Cast-iron or carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
 - 2. Marine type for water box with piping connections. Standard type for water box without piping connections.
 - 3. Provide marine water-box covers with lifting lugs or eyebolts.
 - 4. Hinged marine water-box covers.
 - 5. Nozzle Pipe Connections: Grooved with mechanical-joint coupling
 - 6. Thermistor or RTD temperature sensor factory installed in each nozzle.
 - 7. Fit each water box with 3/4-inch drain connection at low point and vent connection at high point, each with threaded plug.
- H. Additional Corrosion Protection:
 - 1. Electrolytic corrosion-inhibitor anode.

2.7 INSULATION

- A. Closed-cell, flexible elastomeric thermal insulation complying with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
 - 1. Thickness: 1-1/2 inches.
- B. Adhesive: As recommended by insulation manufacturer.
- C. Insulation over all cold surfaces of chiller capable of forming condensation. Components shall include, but not be limited to, evaporator shell and end tube sheets, evaporator water boxes including nozzles, refrigerant suction pipe from evaporator to compressor, cold surfaces of compressor, refrigerant-cooled motor, and auxiliary piping.
 - 1. Apply adhesive to 100 percent of insulation contact surface.
 - 2. Before insulating steel surfaces prepare surfaces for paint, and prime and paint as indicated for other painted components. Do not insulate unpainted steel surfaces.
 - 3. Seal seams and joints to provide a vapor barrier.
 - 4. After adhesive has fully cured, paint exposed surfaces of insulation to match other painted parts.

2.8 Variable Frequency Drive

- A. The centrifugal water chiller shall be furnished with a refrigerant cooled variable speed drive (VSD) as shown on the drawings. The VSD shall be factory mounted on the chiller and shipped completely factory assembled, wired and tested.
- B. The VSD will be specifically designed to interface with the centrifugal water chiller controls and allow for the operating ranges and specific characteristics of the chiller. The VSD control logic shall optimize chiller efficiency by coordinating compressor motor speed and

compressor inlet guide vane position to maintain the chilled water setpoint while avoiding surge. If a surge is detected, VSD surge avoidance logic will make adjustments to move away from and avoid surge at similar conditions in the future.

- C. The VSD efficiency shall be 97% or better at full speed and full load. Fundamental displacement power factor shall be a minimum of 0.96 at all loads.
- D. The VSD shall be solid state, microprocessor based pulse-width modulated (PWM) design. The VSD shall be voltage and current regulated. Output power devices shall be IGBT transistors.
- E. Power semi-conductor and capacitor cooling shall be from a liquid cooled heatsink.
- F. The VSD shall be refrigerant cooled to minimize maintenance and maximize cooling efficiency. If a water cooling design is used, especially an open loop condenser water design, a cleanable shell and tube heat exchanger must be supplied. Plate and frame heat exchangers are not allowed.
- G. The VSDs shall each be furnished in a NEMA 1 metal enclosure having as minimum a short circuit current rating (SCCR) of 65,000 amps per UL 508. It will include three phase input lugs plus a grounding lug for electrical connections, output motor connection via factory installed bus bars and all components properly segregated and completely enclosed in a single metal enclosure.
- H. Enclosure shall include a padlockable, door-mounted circuit breaker with shunt trip and AIC rating of 65,000 amps.
- I. The entire chiller package shall be UL/CUL listed.
- J. The VSD shall be tested to ANSI/UL Standard 508 and shall be listed by a Nationally Recognized Testing Laboratory (NRTL) as designated by OSHA.
- K. The VSD design shall include a standard integrated active rectification control system to limit total demand distortion (TDD) in current at the VSD to less than or equal to 5% as measured at the VSD input, in compliance to recommendations stated in IEEE 519-1992.
 - 1. If active or passive filters are used to meet the less than or equal to 5% TDD, then the losses associated with the filter shall be included in the chiller performance on the selection (adjust penalties accordingly).
 - 2. If a remote mounted filter is used to meet the less than or equal to 5% TDD, then the losses associated with the filter shall be included in the chiller performance on the selection (adjust penalties accordingly). Additionally, the remote filter must be brought in and tested along with the chiller for all applicable tests.
 - 3. If a remote mounted filter is used and is required to be tested, the contractor is responsible for all associated installation costs of the remote filter for testing.
- L. Input shall be nominal 460 480V, 60Hz three phase AC power, ± 10 percent of nominal voltage.
- M. Line frequency 38-60 hertz.

- N. The VSD shall include the following features:
 - All control circuit voltages are physically and electrically isolated from power circuit voltage.
 - 150% instantaneous torque available for improved surge control.
 - Soft start, adjustable linear acceleration, coast-to-stop.
 - Insensitivity to incoming power phase sequence.
 - Adjustable current limiting and U.L. approved electronic motor overload protection.
 - Output line-to-line short circuit protection.
 - Line-to-ground short circuit protection.
 - Protection from phase loss at AFD input.
 - Protection from phase reversal/imbalance.
 - Protection from over/under-voltage.
 - Protection from over-temperature.
- O. The following VSD status indicators shall be available to facilitate startup and maintenance:
 - Output speed in hertz and rpm.
 - Input line voltage.
 - Input line kW.
 - Output/load amps.
 - Average current in percent RLA.
 - Load power factor.
 - Fault.
 - VSD transistor temperature.
 - Service Conditions at full output power:
 - No external venting or heat exchangers shall be required.
 - Operating ambient temperature of 32°F 104°F (0°C 40°C).
 - Room ambient up to 95% relative humidity.

2.9 CONTROLS

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

TLC Engineering Solutions

Project No. 121505 Centrifugal Water Chillers Section 23 6416 - 10

- A. The chiller shall be controlled by a unit mounted, stand-alone Direct Digital Control (DDC) system. A dedicated chiller microprocessor control panel is to be supplied with each chiller by the chiller manufacturer.
- B. Enclosure shall be unit mounted NEMA 250 Type 1.
- C. The chiller manufacturer shall include a pressure, non-mechanical based flow switch that is of the thermal dispersion type for each evaporator and condenser to verify flow through the unit.
- D. A color, touch sensitive liquid crystal display (LCD) shall be unit mounted and a minimum of 12.1" diagonal. The display shall be fully adjustable in height and viewing angle. Animated graphical representations of chiller subsystem operation shall be used to enhance the user interface.
- E. Display shall consist of a menu driven interface with easy touch screen navigation to organized sub-system reports for compressor, evaporator, condenser, purge and motor information as well as associated diagnostics. The controller shall display all active diagnostics and a minimum of 20 historical diagnostics.
- F. The chiller control panel shall provide control of chiller operation and monitoring of chiller modules, sensors, actuators, relays and switches. The chiller control panel shall include controls to safely and efficiently operate the chiller.
- G. Control authority must be capable of handling at least four conditions: Off, local manual at the chiller, local automatic at the chiller and automatic control through a remote source.
- H. Capability to connect a laptop to service utility with applicable software from manufacturer and obtain enhanced set-up and diagnostics.
- I. The front of the chiller control panel shall display the following in clear language, without the use of codes, look-up tables, or gauges:
 - Run time.
 - Number of starts.
 - Current chiller operating mode.
 - Chilled water set point and set point source.
 - Electrical current limit set point and set point source.
 - Entering and leaving evaporator water temperatures.
 - Entering and leaving condenser water temperatures.
 - Saturated evaporator and condenser refrigerant temperatures.
 - Evaporator and condenser refrigerant pressure.
 - Oil tank temperature.
 - Oil tank pressure.

Project No. 121505 Centrifugal Water Chillers Section 23 6416 - 11

- Oil pump discharge pressure.
- Differential oil pressure.
- Compressor motor current per phase.
- Compressor motor percent RLA.
- Compressor motor voltage per phase.
- kW energy consumption and power factor.
- Compressor motor winding temperatures per phase.
- Purge operating mode.
- Purge operating status.
- Time until next purge run.
- Daily pump out 24 hours.
- Average daily pump out 7 Days.
- Purge refrigerant compressor suction temp.
- Purge liquid temp (chiller condenser saturated refrigerant temperature).
- Daily pump out limit/alarm.
- Bearing oil temperatures.
- Discharge temperature (compressor).
- J. The chiller control panel shall provide password protection of all setpoints.
 - The controller shall have the ability to display all primary sub-system operational parameters on dedicated trending graphs. The operator must be able to create up to 6 additional custom trend graphs, choosing up to 10 unique parameters for each graph to trend log data parameters simultaneously over an adjustable period and frequency polling.
 - The chiller control panel shall provide individual relay outputs to start/stop the evaporator and condenser water pumps. The condenser water pump relay output can be used to enable the cooling tower temperature controls.
 - The chiller control panel shall provide leaving chilled water temperature reset based upon return water temperature.
 - The chiller control panel shall be capable of displaying system data in I-P or SI units.
 - Safeties the chiller control panel shall provide the following safeties:

- Low chilled water temperature.
- Low evaporator refrigerant temperature or pressure.
- High condenser refrigerant pressure.
- Evaporator and condenser water flow status.
- Low oil pressure.
- Low oil temperature.
- High oil temperature.
- High motor winding temperatures.
- High motor current.
- AFD function faults.
- Sensor faults.
- Unit controls operation.
 - The chiller control panel or starter shall incorporate advanced motor protection to safeguard the motor throughout the starting and running cycles from the adverse effects of:
 - o Current phase loss.
 - Current phase unbalance.
 - o Current phase reversal.
 - o Under/Over voltage.
 - Motor current overload.
 - Distribution fault protection with auto restart consisting of three-phase current sensing devices that monitor the status of the current.
 - AFD/VFD communication-control failure.
- K. Compressor discharge temperature.
- L. High bearing temperatures.
 - Each of the compressor and motor bearings (including high speed, low speed, and thrust bearings) shall have factory installed, separate temperature sensors installed on the bearing or in the oil return line of each separate bearing.
 - If any oil temperature reaches or exceeds a set value, the chiller control panel shall shut down the chiller, display the diagnostic, and activate the front panel alarm indicator.

- M. The chiller control panel shall provide evaporator freeze protection and low limit control to avoid low evaporator refrigerant temperature trip-outs during critical periods of chiller operation. Whenever this control is in effect, the controller shall indicate that the chiller is in adaptive mode. If the condition exists for more than 30 seconds, a limit warning alarm relay shall energize.
- N. The chiller control panel shall be capable of providing short cycling protection.
- O. The chilled water controller of each chiller shall include variable water-flow capability to allow the chiller to respond quickly to accelerating or decelerating water, and have the following features:
 - The variable water-flow compensation capability shall allow control of the leaving chilled water temperature to within +/- 1.0°F (0.6°C) at a water flow rate change of 30% per minute and will stay online at a water flow rate change of 50% per minute.
- P. The chiller and controller shall include factory mounted transducers to read the differential evaporator water pressure (psid) and condenser water pressure (psid). The following parameters shall be displayed on the unit control display:
 - Evaporator differential pressure (psid).
 - Condenser differential pressure (psid).
 - Evaporator flow rate (GPM).
 - Condenser water flow (GPM).
 - Evaporator capacity (Tons).
- Q. The chiller, upon power loss restoration, he chiller time to fully load up to 80% shall be no longer than 5 minutes. The manufacturer shall supply documentation to support their ability to do this.
- R. The chiller control panel shall provide condenser limit control by including a condenser (refrigerant side) pressure transducer and interconnecting piping and wiring. This control shall be used to avoid high condenser refrigerant pressure tripouts. The control shall take action in response to the condenser refrigerant pressure. Whenever this control is in effect, the panel will automatically indicate that the chiller is in adaptive mode and if the condition exists for more than 30 seconds, a limit warning alarm shall energize.
- S. The chiller controller must be able to communicate directly to a building automation system using BACnet protocol (MSTP-RS 485).

2.10 FINISH

- Paint chiller, using manufacturer's standard procedures, except comply with the following minimum requirements:
- Provide at least one coat of primer with a total dry film thickness of at least 2 mils.
- Provide at least two coats of alkyd-modified, vinyl enamel finish with a total dry film thickness of at least 4 mils.
- Paint surfaces that are to be insulated before applying the insulation.
- Color of finish coat to be manufacturer's standard.

- Vibration Isolation:
 - Chiller manufacturer shall furnish vibration isolation for each chiller.
- Neoprene Pad:
 - Two layers of 0.375-inch- thick, ribbed- or waffle-pattern neoprene pads separated by a 16-gage, stainless-steel plate.
 - Provide stainless-steel square bearing plate to load the pad uniformly between 20 and 40 psig with a 0.12- to 0.16-inch deflection.

2.11 SOURCE QUALITY CONTROL

- A. Perform functional run tests of chillers before shipping.
- B. Factory performance test chillers, before shipping, according to ARI 550/590.
 - Test the following conditions:
 - Design conditions indicated.
- C. Allow Owner access to place where chillers are being tested. Notify Architect 14 days in advance of testing.
- D. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine chillers before installation. Reject chillers that are damaged.
- B. Examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, and electrical connections to verify actual locations, sizes, and other conditions affecting chiller performance, maintenance, and operations before equipment installation.
- C. Final chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
 - Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CHILLER INSTALLATION

- A. Equipment Mounting: Install chiller on concrete bases using elastomeric pads. Comply with requirements for concrete bases specified in Division 03 Section Miscellaneous Cast-in-Place Concrete." Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- B. Minimum Deflection: 1/4 inch.

- C. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
- D. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
- E. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
- F. Install anchor bolts to elevations required for proper attachment to supported equipment.
- G. Maintain manufacturer's recommended clearances for service and maintenance.
- H. Charge chiller with refrigerant and fill with oil if not factory installed.
- I. Install separate devices furnished by manufacturer and not factory installed.

3.3 CONNECTIONS

- A. Comply with requirements for piping specified in Division 23 Section "Hydronic Piping" and Division 23 Section "Refrigerant Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to chiller to allow service and maintenance.
- C. Evaporator Fluid Connections: Connect to evaporator inlet with shutoff valve, flexible connector, thermometer, and plugged tee with pressure gage. Connect to evaporator outlet with shutoff valve, balancing valve, flexible connector, flow switch, thermometer, plugged tee with shutoff valve and pressure gage, and drain connection with valve. Make connections to chiller with a flange or mechanical coupling.
- D. Condenser-Fluid Connections: Connect to condenser inlet with shutoff valve, flexible connector, thermometer, and plugged tee with pressure gage. Connect to condenser outlet with shutoff valve, balancing valve, flexible connector, flow switch, thermometer, plugged tee with shutoff valve and pressure gage, and drain connection with valve. Make connections to chiller with a flange or mechanical coupling.
- E. Refrigerant Pressure Relief Device Connections: For chillers installed indoors, extend vent piping to the outdoors without valves or restrictions. Comply with ASHRAE 15. Connect to chiller pressure relief device with flexible connector and dirt leg with drain valve.
- F. For chillers equipped with a purge system, extend purge vent piping to the outdoors. Comply with ASHRAE 15 and ASHRAE 147.
- G. Connect each chiller drain connection with a union and drain pipe, and extend pipe, full size of connection, to floor drain. Provide a shutoff valve at each connection.

3.4 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Complete installation and startup checks according to manufacturer's written instructions.

- C. Verify that refrigerant charge is sufficient and chiller has been leak tested.
 - Verify that pumps are installed and functional.
 - Verify that thermometers and gages are installed.
 - Operate chiller for run-in period.
 - Check bearing lubrication and oil levels.
 - Verify that refrigerant pressure relief device is vented outside.
 - Verify proper motor rotation.
 - Verify static deflection of vibration isolators, including deflection during chiller startup and shutdown.
 - Verify and record performance of fluid flow and low-temperature interlocks for evaporator and condenser.
 - Verify and record performance of chiller protection devices.
 - Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
 - Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assembly, installation, and connection.
 - Prepare test and inspection startup reports.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain chillers.

END OF SECTION 23 6416

SECTION 23 6500 COOLING TOWERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Open-circuit, induced-draft, counter flow cooling towers.

1.3 DEFINITIONS

- A. BMS: Building management system.
- B. FRP: Fiber-reinforced polyester.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design cooling tower support structure and wind restraints, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Cooling tower support structure shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to SEI/ASCE 7.
 - 1. Wind Loads: 140 mph.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, pressure drop, fan performance data, rating curves with selected points indicated, furnished specialties, and accessories.
 - 1. Maximum flow rate.
 - 2. Minimum flow rate.
 - 3. Drift loss as percent of design flow rate.
 - 4. Volume of water in suspension for purposes of sizing a remote storage tank.
 - 5. Sound power levels in eight octave bands for operation with fans off, fans at minimum, and design speed.
 - 6. Performance curves for the following:
 - a. Varying entering-water temperatures from design to minimum.
 - b. Varying ambient wet-bulb temperatures from design to minimum.
 - c. Varying water flow rates from design to minimum.
 - d. Varying fan operation (off, minimum, and design speed).
 - 7. Fan airflow, brake horsepower, and drive losses.
- 8. Pump flow rate, head, brake horsepower, and efficiency.
- 9. Motor amperage, efficiency, and power factor at 100, 75, 50, and 25 percent of nameplate horsepower.
- 10. Electrical power requirements for each cooling tower component requiring power.
- B. Shop Drawings: Complete set of manufacturer's prints of cooling tower assemblies, control panels, sections and elevations, and unit isolation. Include the following:
 - 1. Assembled unit dimensions.
 - 2. Weight and load distribution.
 - 3. Required clearances for maintenance and operation.
 - 4. Sizes and locations of piping and wiring connections.
 - 5. Wiring Diagrams: For power, signal, and control wiring.
- C. Delegated-Design Submittal: For cooling tower support structure indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Detail fabrication and assembly of support structure.
 - 2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
 - 3. Design Calculations: Calculate requirements for selecting vibration isolators and wind restraints and for designing vibration isolation bases.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Certified by CTI.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 "Heating, Ventilating, and Air-Conditioning."
- D. CTI Certification: Cooling tower thermal performance according to CTI STD 201, "Certification Standard for Commercial Water-Cooling Towers Thermal Performance."
- E. FMG approval and listing in the latest edition of FMG's "Approval Guide."

1.7 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures.
- C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace the following components of cooling towers that fail in materials or workmanship within specified warranty period:
 - 1. Fan assembly including fan, drive, and motor.
 - 2. All components of cooling tower.
 - 3. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 OPEN-CIRCUIT, INDUCED-DRAFT, COUNTERFLOW COOLING TOWERS

- A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Marley, NC Series
 - 2. Baltimore Air Coil
- B. Fabricate cooling tower mounting base with reinforcement strong enough to resist cooling tower movement during a seismic event when cooling tower is anchored to field support structure.
- C. Cooling tower designed to resist wind load of 30 lbf/sq. ft.
- D. Casing and Frame:
 - 1. Casing Material: <u>304</u> Stainless steel.
 - 2. Frame Material: <u>304</u> Stainless steel.
 - 3. Fasteners: <u>304</u> Stainless steel.
 - 4. Joints and Seams: Sealed watertight.
 - 5. Welded Connections: Continuous and watertight.
- E. Collection Basin:
 - 1. Material: <u>304</u> Stainless steel.
 - 2. Strainer: Removable stainless-steel strainer with openings smaller than nozzle orifices.
 - 3. Overflow and drain connections.
 - 4. Makeup water connection.
 - 5. Outlet Connection: ASME B16.5, Class 150 flange.
 - 6. Removable equalization flume plate between adjacent cells of multiple-cell towers.
 - 7. Equalizer connection for field-installed equalizer piping.
- F. Mechanically Operated, Collection Basin Water-Level Control: Manufacturer's standard adjustable, mechanical float assembly and valve.
- G. Pressurized Water Distribution Piping: Main header and lateral branch piping designed for even distribution over heat-exchanger coil or fill throughout the flow range without the need for balancing valves and for connecting individual, removable, nonclogging spray nozzles.
 - 1. Pipe Material: Galvanized steel.
 - 2. Spray Nozzle Material: Polypropylene.

- 3. Piping Supports: Corrosion-resistant hangers and supports to resist movement during operation and shipment.
- H. Fill:
 - 1. Materials: CPVC, resistant to rot, decay, and biological attack; with maximum flamespread index of 25 according to ASTM E 84.
 - 2. Minimum Thickness: 20 mils before forming.
 - 3. Fabrication: Fill-type sheets, fabricated, formed, and bonded together after forming into removable assemblies that are factory installed by manufacturer.
 - 4. Fill Material Operating Temperature: Suitable for entering-water temperatures up through 120 deg F.
- I. Removable Drift Eliminator:
 - 1. Material: FRP or PVC; resistant to rot, decay, and biological attack; with maximum flame-spread index of 25 according to ASTM E 84.
 - 2. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
 - 3. Configuration: Multipass, designed and tested to reduce water carryover to achieve performance indicated.
- J. Air-Intake Louvers:
 - 1. Material: FRP or PVC.
 - 2. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
 - 3. Louver Blades: Arranged to uniformly direct air into cooling tower, to minimize air resistance, and to prevent water from splashing out of tower during all modes of operation including operation with fans off.
- K. Removable Air-Intake Screens: Polymer-coated, galvanized steel wire mesh.
- L. Axial Fan: Balanced at the factory after assembly:
 - 1. Blade Material: Galvanized steel.
 - 2. Hub Material: Galvanized steel.
 - 3. Blade Pitch: Field adjustable.
 - 4. Protective Enclosure: Removable, galvanized-steel, wire-mesh screens, complying with OSHA regulations.
 - 5. Fan Shaft Bearings: Self-aligning ball or roller bearings with moisture-proof seals and premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 deg F. Bearings designed for an L-10 life of 50,000 hours.
 - 6. Bearings Grease Fittings: Extended lubrication lines to an easily accessible location.
- M. Direct Drive: Fan hub directly connected, and properly secured, to motor shaft.
- N. Gear Drive: Right angle, reduced speed, and designed for cooling tower applications according to CTI STD 111. Motor and gear drive shall be aligned before shipment.
 - 1. Gear Drive and Coupling Service Factor: 2.0 based on motor nameplate horsepower.
 - 2. Housing: Cast iron, with epoxy or polyurethane finish, beveled high-strength steel gears continuously bathed in oil, and with lubrication to other internal parts at all operating speeds.

- 3. Mounting: Directly mounted to fan hub and connected to motor so motor shaft is in horizontal position.
- 4. Operation: Able to operate both forward and in reverse.
- 5. Drive-to-Motor Connection: Connected to motor located outside of cooling tower casing by a full-floating drive shaft.
- 6. Drive Shaft Material: Stainless steel, and fitted with flexible couplings on both ends. Provide exposed shaft and couplings with guards according to OSHA regulations.
- 7. Extend oil fill, drain, and vent to outside of cooling tower casing using galvanizedsteel piping. Provide installation with oil-level sight glass.
- O. Fan Motor:
 - 1. General Requirements for Fan Motors: Comply with NEMA designation and temperature-rating requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment" and not indicated below.
 - 2. Motor Enclosure: Totally enclosed fan cooled (TEFC) with epoxy or polyurethane finish.
 - 3. Energy Efficiency: Comply with ASHRAE/IESNA 90.1
 - 4. Service Factor: 1.15.
 - 5. Insulation: Class F or Class H.
 - Variable-Speed Motors: Inverter-duty rated per NEMA MG-1, Section IV, "Performance Standard Applying to All Machines," Part 31, "Definite-Purpose, Inverter-Fed, Polyphase Motors."
 - 7. Motor Location: Mounted outside of cooling tower casing and cooling tower discharge airstream.
 - 8. Severe-duty rating with the following features:
 - a. Rotor and stator protected with corrosion-inhibiting epoxy resin.
 - Double-shielded, vacuum-degassed bearings lubricated with premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 deg F
 - c. Internal heater automatically energized when motor is de-energized.
 - 9. Motor Base: Adjustable or other suitable provision for adjusting belt tension.
- P. Fan Discharge Stack: Material shall match casing, velocity recovery design.
 - 1. Stack Extension: Fabricated to extend above fan deck 2' 0" unless otherwise indicated.
 - 2. Stack Termination: Wire-mesh, galvanized-steel screens; complying with OSHA regulations.
- Q. Vibration Switch: For each fan drive.
 - 1. Enclosure: NEMA 250, Type 4X.
 - 2. Vibration Detection: Sensor with a field-adjustable, acceleration-sensitivity set point in a range of 0 to 1 g and frequency range of 0 to 3000 cycles per minute. Cooling tower manufacturer shall recommend switch set point for proper operation and protection.
 - 3. Provide switch with manual-reset button for field connection to a BCS and hardwired connection to fan motor electrical circuit.
 - 4. Switch shall, on sensing excessive vibration, signal an alarm through BCS and shut down the fan.

- R. Gear-Drive, Oil-Level Switch: Low-oil-level warning switch for connection to BCS.
 - 1. Switch shall, on reaching a low-oil-level set point recommended by cooling tower manufacturer, signal an alarm through the BCS.
- S. Controls: Comply with requirements in Division 23 Section "Instrumentation and Control for HVAC."
- T. Personnel Access Components:
 - 1. Doors: Large enough for personnel to access cooling tower internal components from both cooling tower end walls. Doors shall be operable from both sides of the door.
 - 2. External Ladders with Safety Cages: Aluminum, fixed ladders with ladder extensions to access external platforms and top of cooling tower from adjacent grade without the need for portable ladders. Comply with 29 CFR 1910.27.
 - 3. External Platforms with Handrails: Aluminum, bar grating at cooling tower access doors when cooling towers are elevated and not accessible from grade.
 - 4. Handrail: Aluminum, complete with knee rail and toe board, around top of cooling tower. Comply with 29 CFR 1910.23.
 - 5. Internal Platforms: Aluminum, bar grating.
 - a. Spanning the collection basin from one end of cooling tower to the other and positioned to form a path between the access doors. Platform shall be elevated so that all parts are above the high water level of the collection basin.
 - b. Elevated internal platforms with handrails accessible from fixed vertical ladders to access the fan drive assembly when out of reach from collection basin platform.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Before cooling tower installation, examine roughing-in for tower support, anchor-bolt sizes and locations, piping, and electrical connections to verify actual locations, sizes, and other conditions affecting tower performance, maintenance, and operation.
 - 1. Cooling tower locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install cooling towers on support structure indicated.
- B. Equipment Mounting: Install cooling tower on concrete bases using elastomeric mounts. Comply with requirements in Division 03 Section "Miscellaneous Cast-in-Place Concrete". Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
 - 1. Minimum Deflection: 1/2 inch.
 - 2. Provide stainless steel plate to equally distribute weight over elastomeric pad.

- 3. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
- 4. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
- 5. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
- C. Equipment Mounting: Install cooling tower on concrete bases. Comply with requirements in Division 03 Section "Miscellaneous Cast-in-Place Concrete."
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
- D. Install anchor bolts to elevations required for proper attachment to supported equipment.
- E. Maintain manufacturer's recommended clearances for service and maintenance.
- F. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to cooling towers to allow service and maintenance.
- C. Install flexible pipe connectors at pipe connections of cooling towers mounted on vibration isolators.
- D. Provide drain piping with valve at cooling tower drain connections and at low points in piping.
- E. Connect cooling tower overflows and drains, and piping drains to sanitary sewage system.
- F. Domestic Water Piping: Comply with applicable requirements in Division 22 Section "Domestic Water Piping." Connect to water-level control with shutoff valve and union, flange, or mechanical coupling at each connection.
- G. Supply and Return Piping: Comply with applicable requirements in Division 23 Section "Hydronic Piping." Connect to entering cooling tower connections with shutoff valve, balancing valve, thermometer, plugged tee with pressure gage, flow meter and drain connection with valve. Connect to leaving cooling tower connection with shutoff valve. Make connections to cooling tower with a union, flange, or mechanical coupling.

H. Equalizer Piping: Piping requirements to match supply and return piping. Connect an equalizer pipe, full size of cooling tower connection, between tower cells. Connect to cooling tower with shutoff valve.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.
- C. Obtain performance data from manufacturer.
 - 1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
 - a. Clean entire unit including basins.
 - b. Verify that accessories are properly installed.
 - c. Verify clearances for airflow and for cooling tower servicing.
 - d. Check for vibration isolation and structural support.
 - e. Lubricate bearings.
 - f. Verify fan rotation for correct direction and for vibration or binding and correct problems.
 - g. Adjust belts to proper alignment and tension.
 - h. Verify proper oil level in gear-drive housing. Fill with oil to proper level.
 - i. Operate variable-speed fans through entire operating range and check for harmonic vibration imbalance. Set motor controller to skip speeds resulting in abnormal vibration.
 - j. Check vibration switch setting. Verify operation.
 - k. Verify water level in tower basin. Fill to proper startup level. Check makeup water-level control and valve.
- D. Start cooling tower and associated water pumps. Follow manufacturer's written starting procedures.
- E. Prepare a written startup report that records the results of tests and inspections.

3.6 ADJUSTING

- A. Set and balance water flow to each tower inlet.
- B. Adjust water-level control for proper operating level.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain cooling towers.

END OF SECTION

SECTION 23 6700 DIRECT DIGITAL CONTROL (DDC) SYSTEMS

PART 1 - GENERAL

1.0 SECTION INCLUDES

- A. General Description
- B. Architecture/Communication
- C. Operator Interface
- D. Application and Control Software
- E. System Controllers
- F. General Programmable Controllers
- G. Terminal Unit Programmable Controllers
- H. Packaged Equipment Interface

1.1 GENERAL DESCRIPTION

- A. The building automation system (BAS) will be a web-based Trane Tracer SC[™] or equivalent. Supervisory controller will be capable of communication via BACnet MS/TP, BACnet over ZigBee, BACnet IP, LonTalk[™], Modbus IP, and Modbus RTU protocols simultaneously at the system level to allow for seamless integration with future equipment expansions. User interface will be web based with access available via any standard internet browser. Systems employing proprietary PC software to facilitate remote access will not be acceptable.
- B. The existing BAS serving the facility utilizes the Trane Tracer SC[™] platform. It is the design intent of this specification to extend and or expand the existing BAS to encompass the newly installed systems such that the facility maintains a single unified user interface and all controls hardware is representative of a single product platform. In the event that a BAS platform other that Trane Tracer SC[™] is to be utilized to execute this project, the installing contractor must furnish and install replacement controls hardware and software for all of the existing systems currently associated with the Trane Tracer SC[™] system. Installation of a standalone BAS operating in parallel with the Trane Tracer SC[™] will not be acceptable nor will the use of gateways, bridges, or other integration platforms to tie new non-Trane devices into the existing system. Placing web based links or shortcuts on existing user terminals or the existing system graphics which redirect users to an independent user interface will also not be acceptable.

1.2 ARCHITECTURE/COMMUNICATION

- A. This BAS will be comprised of a high speed Ethernet network utilizing BACnet/IP communications between System Controllers, Workstations, and user access points. Communications between System Controllers and sub-networks of programmable application controllers will utilize BACnet MS/TP or BACnet of ZigBee communications.
 - 1. Each System Controller will perform communications to a network of programmable application controllers using BACnet/MSTP (RS485) or BACnet over ZigBee (wireless) as prescribed by the BACnet standard (ASHRAE 135).
 - a. Each System Controller will function as a BACnet router to each unit controller providing a unique BACnet Device ID for all controllers within the system.

1.3 OPERATOR INTERFACE

- A. The user interface will be Web-Based with access available via any device with access to the facility local area network (LAN) equipped with a compatible internet browser as defined below. The installing BAS contractor will provide one (1) laptop PC meeting the minimum system requirements to access the web based user interface to the owner as part of this project.
- B. The operator interface will reside on the Enterprise wide network, which is same high-speed communications network as the System Controllers. The Enterprise wide network will be provided by the owner and support the Internet Protocol (IP).
 - 1. Operator Interface:
 - a. The operator interface will be accessible via a web browser.
 - b. The operator interface will support the following Internet web browsers:
 - 1) Internet Explorer 8.0+
 - 2) Firefox 4.0+
 - 3) Chrome 10.0+
 - 4) Microsoft Edge
 - c. The operator interface will support the following mobile web browsers:
 - 1) iOS (iPad/iPhone) V4.0+
 - 2) Android (Tablet) V4.0+
 - 3) Android (Phone) V2.3+
 - 4) Microsoft Edge
 - d. System Security:
 - 1) Each operator will be required to login to the system with a user name and password in order to view, edit, add, or delete data.
 - 2) User Profiles will restrict the user to only the objects, applications, and system functions as assigned by the system administrator.
 - 3) Each operator will be allowed to change their user password
 - 4) The System Administrator will be able to manage the security for all other users
 - 5) The system will include pre-defined "roles" that allow a system administrator to quickly assign permissions to a user.
 - 6) User logon/logoff attempts will be recorded.
 - 7) The system will protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time will be user definable.
 - 8) All system security data will be stored in an encrypted format.
 - e. Database:
 - 1) Database Save. A system operator with the proper password clearance will be able to archive the database on the designated operator interface PC.
 - 2) Database Restore. The system operator will also be able to clear a panel database and manually initiate a download of a specified database to any panel in the system.
 - f. On-Line Help and Training:
 - 1) Provide a context sensitive, on line help system to assist the operator in operation and configuration of the system.

- 2) On-line help will be available for all system functions and will provide the relevant data for each particular screen.
- g. System Diagnostics
 - 1) The system will automatically monitor the operation of all network connections, building management panels, and controllers.
 - 2) The failure of any device will be annunciated to the operators.
- h. Equipment & Application Pages
 - 1) The operator interface will include standard pages for all equipment and applications. These pages will allow an operator to obtain information relevant to the operation of the equipment and/or application, including:
 - a) Animated Equipment Graphics for each major piece of equipment and floor plan in the System. This includes:
 - (1) Each Chiller, Air Handler, VAV Terminal, Fan Coil, Boiler, and Cooling Tower. These graphics will show all points dynamically as specified in the points list.
 - (2) Animation capabilities will include the ability to show a sequence of images reflecting the position of analog outputs, such as valve or damper positions. Graphics will be capable of launching other web pages.
 - b) Alarms relevant to the equipment or application without requiring a user to navigate to an alarm page and perform a filter.
 - c) Historical Data (As defined in Automatic Trend Log section below) for the equipment or application without requiring a user to navigate to a data log page and perform a filter.
- i. System Graphics. Operator interface will be graphically based and will include at least one graphic per piece of equipment or occupied zone, graphics for each chilled water and hot water system, and graphics that summarize conditions on each floor of each building included in this contract. Indicate thermal comfort on floor plan summary graphics using colors to represent zone temperature relative to zone set point.
 - Functionality. Graphics will allow operator to monitor system status, to view a summary of the most important data for each controlled zone or piece of equipment, to use point and-click navigation between zones or equipment, and to edit set points and other specified parameters.
 - Graphic imagery graphics will use 3D images for all standard and custom graphics. The only allowable exceptions will be photo images, maps, schematic drawings, and selected floor plans.
 - 3) Animation. Graphics will be able to animate by displaying different Image lies for changed object status.
 - 4) Alarm Indication. Indicate areas or equipment in an alarm condition using color or other visual indicator.

- 5) Format. Graphics will be saved in an industry-standard format such as BMP, JPEG, PNG, or GIF. Web-based system graphics will be viewable on browsers compatible with World Wide Web Consortium browser standards. Web graphic format will require no plug-in (such as HTML and JavaScript) or will only require widely available no-cost plug-ins (such as Active-X and Macromedia Flash).
- j. Custom Graphics:
 - 1) The operator interface will be capable of displaying custom graphics in order to convey the status of the facility to its operators.
 - 2) Graphical Navigation. The operator interface will provide dynamic color graphics of building areas, systems and equipment.
 - 3) Graphical Data Visualization. The operator interface will support dynamic points including analog and binary values, dynamic text, static text, and animation files.
 - 4) Custom background images. Custom background images will be created with the use of commonly available graphics packages such as Adobe Photoshop. The graphics generation package will create and modify graphics that are saved in industry standard formats such as GIF and JPEG.
- k. Graphics Library. Furnish a library of standard HVAC equipment such as chillers, air handlers, terminals, fan coils, unit ventilators, rooftop units, and VAV boxes, in 3-dimensional graphic depictions. The library will be furnished in a file format compatible with the graphics generation package program.
- I. Manual Control and Override.
 - 1) Point Control. Provide a method for a user to view, override, and edit if applicable, the status of any object and property in the system. The point status will be available by menu, on graphics or through custom programs.
 - 2) Temporary Overrides. The user will be able to perform a temporary override wherever an override is allowed, automatically removing the override after a specified period of time.
 - 3) Override Owners. The system will convey to the user the owner of each override for all priorities that an override exists.
 - 4) Provide a specific icon to show timed override or operator override, when a point, unit controller or application has been overridden manually.
- m. Engineering Units:
 - 1) Allow for selection of the desired engineering units (i.e. Inch pound or SI) in the system.
 - 2) Unit selection will be able to be customized by locality to select the desired units for each measurement.
 - 3) Engineering units on this project will be IP.

- 2. Scheduling. A user will be able to perform the following tasks utilizing the operator interface:
 - a. Create a new schedule, defining the default values, events and membership.
 - b. Create exceptions to a schedule for any given day.
 - c. Apply an exception that spans a single day or multiple days.
 - d. View a schedule by day, week and month.
 - e. Exception schedules and holidays will be shown clearly on the calendar.
 - f. Modify the schedule events, members and exceptions.
- 3. Trend Logs:
 - a. Trend Logs Definition:
 - 1) The operator interface will allow a user with the appropriate security permissions to define a trend log for any data in the system.
 - 2) The operator interface will allow a user to define any trend log options as described in the Application and Control Software section.
 - b. Trend Log Viewer:
 - 1) The operator interface will allow Trend Log data to be viewed and printed.
 - 2) The operator interface will allow a user to view trend log data in text-based (time stamp/value).
 - 3) The operator will be able to view the data collected by a trend log in a graphical chart in the operator interface.
 - 4) Trend log viewing capabilities will include the ability to show a minimum of 5 points on a chart.
 - 5) Each data point trend line will be displayed as a unique color.
 - 6) The operator will be able to specify the duration of historical data to view by scrolling and zooming.
 - 7) The system will provide a graphical trace display of the associated time stamp and value for any selected point along the x-axis.
 - c. Export Trend Logs:
 - 1) The operator interface will allow a user to export trend log data in CSV or PDF format for use by other industry standard word processing and spreadsheet packages.
- 4. Alarm/Event Notification:
 - a. An operator will be notified of new alarms/events as they occur while navigating through any part of the system via an alarm icon.
 - b. Alarm/Event Log: The operator will be able to view all logged system alarms/events from any operator interface.
 - 1) The operator will be able to sort and filter alarms from events. Alarms will be sorted in a minimum of 4 categories based on severity.

- 2) Alarm/event messages will use full language, easily recognized descriptors.
- 3) An operator with the proper security level may acknowledge and clear alarms/events.
- 4) All alarms/events that have not been cleared by the operator will be stored by the building controller.
- 5) The alarm/event log will include a comment field for each alarm/event that allows a user to add specific comments associated with any alarm.
- c. Alarm Processing:
 - 1) The operator will be able to configure any object in the system to generate an alarm when transitioning in and out of a normal state.
 - 2) The operator will be able to configure the alarm limits, warning limits, states, and reactions for each object in the system.
- 5. Reports and Logs:
 - a. The operator interface will provide a reporting package that allows the operator to select reports.
 - b. The operator interface will provide the ability to schedule reports to run at specified intervals of time.
 - c. The operator interface will allow a user to export reports and logs from the building controller in a format that is readily accessible by other standard software applications including spreadsheets and word processing. Acceptable formats include:
 - 1) CSV, HTML, XML, PDF
 - d. Provide a means to list and access the last 10 reports viewed by the user.
 - e. The following standard reports will be available without requiring a user to manually configure the report:
 - 1) All Points in Alarm Report: Provide an on demand report showing all current alarms.
 - 2) All Points in Override Report: Provide an on demand report showing all overrides in effect.
 - 3) Commissioning Report: Provide a one-time report that lists all equipment with the unit configuration and present operation.
 - 4) Points report: Provide a report that lists the current value of all points

1.4 APPLICATION AND CONTROL SOFTWARE

- A. Furnish the following applications software for building and energy management. All software applications will reside and run in the system controllers. Editing of applications will occur at the operator interface.
 - 1. Scheduling. Provide the capability to schedule each object or group of objects in the system. Each of these schedules will include the capability for start, stop, optimal start, optimal stop, and night economizer actions. Each schedule may consist of up to [10] events. When a

group of objects are scheduled together, provide the capability to define advances and delays for each member. Each schedule will consist of the following:

- a. Weekly Schedule. Provide separate schedules for each day of the week.
- b. Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule. This exception schedule will override the standard schedule for that day. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed it will be discarded and replaced by the standard schedule for that day of the week.
- c. Holiday Schedules. Provide the capability for the operator to define up to 99 special or holiday schedules. These schedules may be placed on the scheduling calendar and will be repeated each year. The operator will be able to define the length of each holiday period.
- d. Optimal Start. The scheduling application outlined above will support an optimal start algorithm. This will calculate the thermal characteristics of a zone and start the equipment prior to occupancy to achieve the desired space temperature at the specified occupancy time. The algorithm will calculate separate sets of heating and cooling rates for zones that have been unoccupied for less then and greater than 24 hours. Provide the ability to modify the start algorithm based on outdoor air temperature. Provide an early start limit in minutes to prevent the system from starting before an operator determined time limit.
- 2. Trend Log Application:
 - a. Trend log data will be sampled and stored on the System Controller panel and will capable of being archived to a BACnet Workstation for longer term storage.
 - 1) Trend logs will include interval, start-time, and stop-time.
 - 2) Trend log intervals will be configurable as frequently as 1 minute and as infrequently as 1 year.
 - b. Automated Trend Logs:
 - 1) The system controller will automatically create trend logs for defined key measurements for each controlled HVAC device and HVAC application.
 - 2) The automatic trend logs will monitor these parameters for a minimum of 7 days at 15 minute intervals. The automatic trend logs will be user adjustable.
 - c. Alarm/Event Log:
 - 1) Any object in the system will be configurable to generate an alarm when transitioning in and out of a normal or fault state.
 - 2) Any object in the system will allow the alarm limits, warning limits, states, and reactions to be configured for each object in the system.
 - d. An alarm/event will be capable of triggering any of the following actions:
 - 1) Route the alarm/event to one or more alarm log:

- a) The alarm message will include the name of the alarm location, the device that generated the alarm, and the alarm message itself.
- 2) Route an e-mail message to an operator(s)
- 3) Log a data point(s) for a period of time
- 4) Run a custom control program
- 3. Point Control. User will have the option to set the update interval, minimum on/off time, event notification, custom programming on change of events.
- 4. Timed Override. A standard application will be utilized to enable/disable temperature control when a user selects on/cancel at the zone sensor, operator interface, or the local operator display. The amount of time that the override takes precedence will be selectable from the operator interface.
- 5. Anti-Short Cycling. All binary output points will be protected from short cycling.

1.5 SYSTEM CONTROLLERS

- A. There will be one or more independent, standalone microprocessor based System Controllers to manage the global strategies described in Application and Control Software section (Trane Tracer SC[™] or approved equivalent)
 - 1. The System Controller will have sufficient memory to support its operating system, database, and programming requirements.
 - 2. The controller will provide a USB communications port for connection to a PC
 - 3. The operating system of the Controller will manage the input and output communications signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.
 - 4. All System Controllers will have a real time clock.
 - 5. The System Controller will continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller will:
 - a. Assume a predetermined failure mode.
 - b. Generate an alarm notification.
 - c. Create a retrievable file of the state of all applicable memory locations at the time of the failure.
 - d. Automatically reset the System Controller to return to a normal operating mode.
 - Environment. Controller hardware will be suitable for the anticipated ambient conditions. Controller used in conditioned ambient will be mounted in an enclosure, and will be rated for operation at -40 F to 122 F.
 - 7. Clock Synchronization.
 - a. All System Controllers will be able to synchronize with a NTP server for automatic time synchronization.

- b. All System Controllers will be able to accept a BACnet time synchronization command for automatic time synchronization.
- c. All System Controllers will automatically adjust for daylight savings time if applicable.
- 8. Serviceability:
 - a. Provide diagnostic LEDs for power, communications, and processor.
 - b. The System Controller will have a display on the main board that indicates the current operating mode of the controller.
 - c. All wiring connections will be made to field removable, modular terminal connectors.
 - d. The System controller will utilize standard DIN mounting methods for installation and replacement.
- 9. Memory. The System Controller will maintain all BIOS and programming information indefinitely without power to the System controller
- 10. Immunity to power and noise. Controller will be able to operate at 90% to 110% of nominal voltage rating and will perform an orderly shut-down below 80% nominal voltage
- 11. BACnet Test Labs (BTL) Listing. Each System Controller will be listed as a Building Controller (B-BC) by the BACnet Test Labs.

1.6 GENERAL PROGRAMMABLE CONTROLLERS

Controllers will be Trane UC600 fully programmable units or approved equivalent. Application specific controllers not capable of accepting custom programs will not be acceptable. Controller operation will not be dependent upon presence of a BAS. If no BAS exists, or communication with the BAS is lost, the controller will be capable of standalone operation utilizing local programming and set points.

- A. Operation:
 - 1. Will operate a schedule in a standalone application using a Real Time Clock.
 - a. The Controller will have a built in schedule (assessable with or without a display)\
 - b. Support will be for at least 3 schedules with up to 10 events for each day of the week.
 - c. Each of the 3 schedules can be Analog, Binary or Multi-State
 - d. The controller will support a minimum of 25 exceptions each with up to 10 events.
 - 2. For ease of troubleshooting, the Controller will support data trend logging
 - a. 25,000 samples minimum
 - b. Trends will be capable of being collected at a minimum sample rate of once every second
 - c. Trends will be capable of being scheduled or triggered.
 - 3. To meet the sequence of operation for each application, the Controller will use library programs provided by the controller manufacturer that are either factory loaded or downloaded with service tool to the Controller.

- 4. Environment. Controller hardware will be suitable for the anticipated ambient conditions.
 - a. Storage conditions:
 - 1) Temperature: -67°F to 203°F (-55°C to 95°C)
 - 2) Humidity: Between 5% to 100% RH (non-condensing)
 - b. Operating conditions:
 - 1) Temperature: -40°F to 158°F (-40°C to 70°C)
 - 2) 'Humidity: Between 5% to 100% RH (non-condensing)
 - c. Controllers used indoors will be mounted in a NEMA 1 enclosure at a minimum
 - d. Controllers used outdoors and/or in wet ambient will be mounted within NEMA 4 type waterproof enclosures, and will be rated for operation at -40 F to 158 F [-40 C to 70 C].
- 5. Input/Output: The Controller will have on board or through expansion module all I/O capable of performing all functionality needed for the application. Controls provided by the equipment manufacture must supply the required I/O for the equipment. In addition other controls must meet the following requirements:
 - a. Will support flexibility in valve type, the controllers will be capable of supporting the following valve control types 0-10VDC, 0-5VDC, 4-20mA, 24VAC - 2 position.
 - b. Will support flexibility in sensor type, the Controller will be of reading sensor input ranges of 0 to10V, 0 to 20mA, 50ms or longer pulses, 200 to 20Kohm and RTD input.
 - c. Will support flexibility in sensor type, all Analog Outputs will have the additional capability of being programmed to operate as Universal Inputs or Pulse Width Modulation Outputs.
 - d. Will support flexibility in sensor type, the Controller and/or expansion modules will support dry and wetted (24VAC) binary inputs.
 - e. The controller support pulse accumulator for connecting devices like energy meters.
 - f. In order to support a wide range of devices, the Controller's binary output will be able to drive at least 10VA each.
 - g. Any I/O that is unused by functionality needed for the equipment will be available to be used by custom program on the Controller and by any other controller on the network.
 - h. The Controller will provide 24VAC and 24VDC power terminals sensors and other devices required.
 - i. The Controller will provide a dedicated static pressure input.
- 6. Input/Output Expandability The Controller will provide the following functionality in order to meet current and future application needs:
 - a. For the application flexibility, the Controller will be capable of expanding to a total of at least 100 hardware I/O terminations.

- b. Expansion I/O can be mounted up to 200m from control
- c. Expansion I/O can be added in as small as 4 point increments.
- d. To keep BACnet MS/TP network traffic to a minimum, expansion I/O must communicate via an internal controller communication bus (point expansion via the BACnet MS/TP network is not allowed)
- 7. Serviceability The Controller will provide the following in order to improve serviceability of the Controller.
 - a. Diagnostic LEDs for power/normal operation/status, BACnet communications, sensor bus communications, and binary outputs. All wiring connections will be clearly labeled and made to be field removable.
 - b. Binary and analog inputs and outputs will use removable connectors or be connected to terminal strip external to the control box
 - c. Software service tool connection through all of the following methods: direct cable connection to the Controller, connection through another controller on BACnet link and through the Controller's zone sensor.
 - d. For configuration, programming, and testing of controller programs must, for safety purposes, be able to be accomplished with the power off to the equipment and the controller.
 - e. The Controller software tool service port will utilize standard of-the-shelf USB printer cable.
 - f. Capabilities to temporarily override the BACnet point values with built-in time expiration in the Controller.
 - g. To aid in service replacement, the Controller will easily attached to standard DIN rail mounting.
 - h. For future expansion, the Controller will be capable of adding sequence of operation programming utilizing service tools software with a graphical programming interface (editing or programming in line code is not permissible).
 - i. To aid in service replacement, the Controller will allow for setting its BACnet address must be rotary switches that correspond to a numerical value for the address to allow the setting of the address without the need of a service tool or the control being powered (DIP switch methodologies are not allowed).
 - j. Controller data will persist through a power failure.
- 8. Software Retention: All Controller operating parameters, set points, BIOS, and sequence of operation code must be stored in non-volatile memory in order to maintain such information for months without power.
- 9. Transformer for the Controller must be rated at minimum of 115% of ASC power consumption, and will be fused or current limiting type. 24 VAC, +/- 15% nominal, 50-60 Hz, 24 VA plus binary output loads for a maximum of 12 VA for each binary output.

- 10. Controller must meet the following Agency Compliance:
 - a. UL916 PAZX, Open Energy Management Equipment
 - b. UL94-5V, Flammability
 - c. FCC Part 15, Subpart B, Class B Limit
 - d. BACnet Testing Laboratory (BTL) Listed
 - e. cUL Marked for international compliance
 - f. CE Marked for international compliance

1.7 TERMINAL UNIT PROGRAMMABLE CONTROLLERS

Controllers will be Trane UC210 fully programmable units or approved equivalent. Application specific controllers not capable of accepting custom programs will not be acceptable. Controller operation will not be dependent upon presence of a BAS. If no BAS exists, or communication with the BAS is lost, the controller will be capable of standalone operation utilizing local programming and set points.

- A. Terminal Unit Controllers are controllers that operate equipment that control the space temperature of a single zone.
 - 1. Software:
 - a. For flexibility to change to sequence of operation in the future, the controller will be capable running custom programs written in a graphical programming language.
 - 2. Environment Controller hardware will be suitable for the anticipated ambient conditions.
 - a. Storage: -55 to 203 0 F (-48 to 95 0 C) and 5 to 95% Rh, non-condensing.
 - b. Operating: -40 to 158 °F (-40 to 70 °C) and 5 to 95% Rh, non-condensing.
 - c. Controllers used indoors will be mounted in a NEMA 1 enclosure at a minimum
 - d. Controllers used outdoors and/or in wet ambient will be mounted within NEMA 4 type waterproof enclosures, and will be rated for operation at -40 F to 158 F [-40 C to 70 C].
 - 3. Input/Output:
 - a. For flexibility in selection and replacement of valves, the controllers will be capable of supporting all of the following valve control types 0-10VDC, 0-5VDC, 4-20mA, 24VAC floating point, 24VAC - 2 position (Normally Open or Normally Closed).
 - b. For flexibility in selection and replacement of sensors, the controllers will be capable of reading sensor input ranges of 0 to10V, 0 to 20mA, pulse counts, and 200 to 20Kohm.
 - c. For flexibility in selection and replacement of binary sensors, the controller will support dry and wetted (24VAC) binary inputs.

- d. For flexibility in selection and replacement devices, the controller's will have binary output which are able to drive at least 12VA each.
- e. For flexibility in selection and replacement of motors, the controller will be capable of outputting 24VAC (binary output), DC voltage (0 to 10VDC minimum range) and PWM (in the 80 to 100 Hz range).
- f. For future needs, any I/O that is unused by functionality of equipment control will be available to be used by custom program on the controller and by another controller on the network.
- g. For future expansion and flexibility, the controller will have either on board or through expansion, 50 hardware input/output points. Expansion points must communicate with the controller via an internal communications bus. Expansion points must be capable of being mounted up to 200 meters from the controller. Expansion points that require the BACnet network for communication with the controller are not allowed.
- 4. Serviceability The controller will provide the following in order to improve serviceability of the controller.
 - a. Diagnostic LEDs will indicate correct operation or failures/faults for all of the following: power, sensors, BACnet communications, and I/O communications bus.
 - b. All binary output will have LED's indicating the output state.
 - c. All wiring connections will removable without the use of a tool.
 - d. Software service tool connection through all of the following methods: direct cable connection to the controller, connection through another controller on BACnet link and through the controller's zone sensor.
 - e. For safety purposes, the controller will be capable of being powered by a portable computer for the purposes of configuration, programming, and testing programs so that this work can be accomplished with the power off to the equipment.
 - f. Capabilities to temporarily override of BACnet point values with built-in time expiration in the controller.
 - g. BACnet Mack Address will be set using decimal (0-9) based rotary switches.
 - h. Configuration change will not be made in a programming environment, but rather by a configuration page utilizing dropdown list, check boxes, and numeric boxes.
 - i. BACnet trending objects resident on controller
 - 1) Minimum of 20,000 trending points total on controller
 - 2) Will be capable of trending all BACnet points used by controller
 - 3) Will be capable of 1 second sample rates on all points
- 5. Software Retention: All Zone Controller operating parameters, set points, BIOS, and sequence of operation code must be stored in non-volatile memory in order to maintain such information for months without power.

- 6. Transformer for the controller must be rated at minimum of 115% of ASC power consumption, and will be fused or current limiting type. 24 VAC, +/- 15% nominal, 50-60 Hz, 24 VA plus binary output loads, for a maximum of 12 VA for each binary output.
- 7. Agency Approval: The controller will meet Agency Compliance:
 - a. UL916 PAZX, Open Energy Management Equipment
 - b. UL94-5V, Flammability
 - c. FCC Part 15, Subpart B, Class B Limit

1.8 PACKAGED EQUIPMENT INTERFACE

A. The BAS will be capable of interfacing with packaged equipment such as Rooftop units (RTUs), chillers, and boilers via BACnet MS/TP or BACnet over ZigBee protocol. All available control points served up by packaged equipment controllers, refer to associated BACnet PICS documentations, will be available for mapping within the BAS interface.

PART 2 - EXECUTION NOT USED

PART 3 - SEQUENCE OF OPERATION NOT USED

END OF SECTION

SECTION 23 7313 MODULAR INDOOR CENTRAL STATION AIR HANDLING UNITS

PART 1 - GENERAL

1.1 **RELATED DOCUMENTS**

Α. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- Α. Section Includes:
 - 1. Constant-air-volume, single-zone air-handling units.

1.3 PERFORMANCE REQUIREMENTS

- Α. Delegated Design: Design vibration isolation and seismic-restraint details, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Casing performance – Casing air leakage shall not exceed leak class 6 (CL = 6) per ASHRAE 111 at specified casing pressure, where maximum casing leakage (cfm/100 ft2 of casing surface area) = $CL \times P0.65$.
- C. Air leakage shall be determined at 1.50 times maximum casing static pressure up to 8 inches w.g. Specified air leakage shall be accomplished without the use of caulk. Total estimated air leakage shall be reported for each unit in CFM, as a percentage of supply air, and as an ASHRAE 111 Leakage Class.

1.4 **SUBMITTALS**

- Product Data: For each air-handling unit indicated. Α.
 - 1. Unit dimensions and weight.
 - 2. Cabinet material, metal thickness, finishes, insulation, and accessories.
 - 3. Fans:
 - Certified fan-performance curves with system operating conditions indicated. a.
 - Certified fan-sound power ratings. b
 - Fan construction and accessories. C.
 - Motor ratings, electrical characteristics, and motor accessories. d.
 - 4. Certified coil-performance ratings with system operating conditions indicated.
 - 5. Dampers, including housings, linkages, and operators.
 - 6. Filters with performance characteristics.
- Β. LEED Submittal:
 - 1. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1-2004, Section 5 - "Systems and Equipment."

Project No. 121505

Section 23 7313 - 1

- C. Delegated-Design Submittal: For vibration isolation and seismic restraints indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
 - 2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
- D. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Roof curb layout and relationships between components and adjacent structural and mechanical elements.
 - 2. Support location, type, and weight.
 - 3. Field measurements.
- E. Source quality-control reports.
- F. Field quality-control reports.
- G. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of airhandling units and components.
- C. ARI Certification: Air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.
- D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 "Systems and Equipment" and Section 7 "Construction and Startup."
- E. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- F. Comply with NFPA 70.

1.6 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate sizes and locations of structural-steel support members, if any, with actual equipment provided.

1.7 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filters: One set(s) for each air-handling unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2.2 UNIT CASINGS

- A. INDOOR AIR HANDLING UNITS
 - 1. Unit manufacturer shall ship separate segments so unit can be broken down for ease of installation in tight spaces. The entire air handler shall be constructed of galvanized steel. Indoor air handling unit casing finish to meet ASTM B117 250-hour salt-spray test. The removal of access panels or access doors shall not affect the structural integrity of the unit. All removable panels shall be gasketed. All doors shall have gasketing around full perimeter to prevent air leakage. Contractor shall be responsible to provide connection flanges and all other framework that is needed to properly support the unit.
 - 2. Unit Base
 - a. Entire indoor air handling unit shall have a 6-inch full perimeter base rail for structural rigidity and condensate trapping.
- B. Casing Insulation, Double Wall:
- 1. Double Wall Insulated Panels:
 - a. Casing performance Casing air leakage shall not exceed leak class 6 (CL = 6) per ASHRAE 111 at specified casing pressure, where maximum casing leakage (cfm/100 ft2 of casing surface area) = CL X P0.65.
 - b. Air leakage shall be determined at 1.50 times maximum casing static pressure up to 8 inches w.g. Specified air leakage shall be accomplished without the use of caulk. Total estimated air leakage shall be reported for each unit in CFM, as a percentage of supply air, and as an ASHRAE 111 Leakage Class.
 - c. Under 52°F supply air temperature and design conditions on the exterior of the unit of 80°F dry bulb and 71°F wet bulb, condensation shall not form on the casing exterior. The AHU manufacturer shall provide tested casing thermal performance for the scheduled supply air temperature plotted on a psychrometric chart. The design condition on the exterior of the unit shall also be plotted on the chart. If tested casing thermal data is not available, AHU manufacturer shall provide, in writing to the Engineer and Owner, a guarantee against condensation forming on the unit exterior at the stated design conditions above. The guarantee shall note that the AHU manufacturer will cover all expenses associated with modifying units in the field should external condensate form on them. In lieu of AHU manufacturer providing a written guarantee, the installing contractor must provide additional external insulation on AHU to prevent condensation.

- d. Unit casing (wall/floor/pressure bulkhead roof panels and doors) shall be able to withstand up to 1.5 times design static pressure up to +8" w.g. in all positive pressure sections and -8" w.g. in all negative pressure sections, whichever is less, and shall not exceed 0.0042" per inch of panel span (L/240).
- e. Floor panels shall be double-wall construction and designed to support a 300-lb load during maintenance activities and shall deflect no more than 0.0042" per inch of panel span.
- f. Unit casing panels shall be 2" double-wall construction, with solid galvanized exterior and **solid stainless steel interior**, to facilitate cleaning of unit interior.
- g. Unit casing panels (pressure bulkhead roof panels, walls, floor) and doors shall be provided with a minimum thermal resistance (R-value) of 13 Hr*Ft2*°F/BTU.
- h. Unit casing panels (pressure bulkhead roof panels, walls, floor) and external structural frame members shall be completely insulated filling the entire panel cavity in all directions so that no voids exist. Panel insulation shall comply with NFPA 90A.
- i. Structural frame must not extend from air-handling unit interior to exterior. All component and panel support structure must be internal to AHU. Casing panel inner liners must not extend to the exterior of the unit or contact the exterior frame. A mid-span, no-through-metal, internal thermal break shall be provided for all unit casing panels.
- j. Access panels and/or access doors shall be provided in all sections to allow easy access to drain pan, coil(s), motor, drive components and bearings for cleaning, inspection, and maintenance.
- k. Access panels and doors shall be fully removable without the use of specialized tools to allow complete access of interior surfaces.
- C. Inspection and Access Doors:
 - 1. Panel and Door Fabrication: Formed and reinforced, double-wall and insulated panels of same materials and thicknesses as casing.
 - 2. Access Doors:
 - a. Hinges: A minimum of two ball-bearing hinges or stainless-steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.
 - b. Gasket: Neoprene, applied around entire perimeters of panel frames.
 - c. Fabricate windows in fan section doors of double-glazed, wire-reinforced safety glass with an air space between panes and sealed with interior and exterior rubber seals.
 - d. Size: At least 18 inches wide by full height of unit casing up to a maximum height of 72 inches.
 - 3. Locations and Applications:
 - a. Fan Section: Doors.
 - b. Access Section: Doors.
 - c. Coil Section: Inspection and access panel.
 - d. Damper Section: Doors.
 - e. Filter Section: Doors large enough to allow periodic removal and installation of filters.
 - f. Mixing Section: Doors.

- 4. Marine lights shall be provided throughout AHUs as indicated on the schedule and plans. Lights shall be instant-on, light-emitting diode (LED) type to minimize amperage draw and shall produce lumens equivalent to a minimum 75W incandescent bulb (1200 lumens). LED lighting shall provide instant-on, white light and have a minimum 50,000 hr life.
 - a. Light fixture shall be weather-resistant, enclosed and gasketed to prevent water and dust intrusion.
 - b. Fixtures shall be designed for flexible positioning during maintenance and service activities for best possible location providing full light on work surface of interest and not being blocked by technician.
 - c. All lights on a unit shall be wired in the factory to a single on-off switch.
 - d. Installing contractor shall be responsible for providing 115V supply to the factorymounted marine light circuit.
- D. Condensate Drain Pans:
 - 1. Fabricated with two percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.
 - a. Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1-2004 and at least six inches downstream of the coil face.
 - b. Depth: A minimum of 2 inches deep.
 - 2. Formed sections.
 - 3. Double-wall, stainless-steel sheet with space between walls filled with minimum 1 inch thick foam insulation and moisture-tight seal.
 - 4. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
 - 5. Allow no standing water. The drain connection shall be on the side of the unit that has the condensate drain plumbing connection. If the selected air handling units have more than one drain connection, each connection shall be provided with a trap and an individual drain line piped to discharge at the nearest condensate floor drain. The discharge of the individual condensate traps shall not be connected together.
 - 6. Units with stacked coils shall have an intermediate drain pan to collect.

2.3 FAN, DRIVE, AND MOTOR SECTION

- A. Fan sections shall have a minimum of one access door located on the drive side of the unit to allow inspection and maintenance of the fan, motor, and drive components.
- B. Provide fans of type and class as specified on the schedule. Fan shafts shall be solid steel, coated with a rust-inhibiting coating, and properly designed so that fan shaft does not pass through first critical speed as unit comes up to rated RPM. All fans shall be statically and dynamically tested by the manufacturer for vibration and alignment as an

assembly at the operating RPM to meet design specifications. Fans controlled by variable frequency drives shall be statically and dynamically tested for vibration and alignment at speeds between 25% and 100% of design RPM. If fans are not factory-tested for vibration and alignment, the contractor shall be responsible for cost and labor associated with field balancing and certified vibration performance. Fan wheels shall be keyed to fan shafts to prevent slipping.

- C. All fans, including direct-drive plenum fans, shall be mounted on spring isolation bases. Internally-mounted motor shall be on the same isolation base. Fan and motor shall be internally isolated with spring isolators. Unit shall have 2-inch spring isolators.
- D. Fan sections containing multiple fans shall be provided as indicated on the schedule and drawings. Each fan shall operate in parallel to each other fan in the array. The fans shall be SWSI plenum type with high efficient AF blades. Fans shall be direct-driven. Fan wheels shall be aluminum. The Hp characteristic of the fans shall be non-overloading.
- E. Fan sections containing multiple fans shall be controlled using a common control signal, such as the duct static control signal, to modulate the fan speed.
- F. Fan airflow measurement systems shall be provided as indicated on the schedule and drawings to measure fan airflow directly or to measure differential pressure that can be used to calculate airflow. The accuracy of the devices shall be no worse than +/- 5 percent when operating within stable fan operating conditions. Devices shall not affect the submitted fan performance and acoustical levels. Devices that obstruct the fan inlet or outlet shall not be acceptable. Devices shall be connected to transducers with a 2-10 VDC output. Signal shall be proportional to air velocity.
- G. Motor Size: Fan Motor: Fan motors shall be an open drip proof ball bearing specifically designed for fan applications, unless otherwise indicated. Refer to paragraph entitled "ELECTRIC MOTOR" in applicable Specification Section for motor efficiency requirements. Unless specifically indicated otherwise air handling unit fan motors shall be selected as follows:
 - a. Less than 5 HP; 135 percent of bHP
 - b. 5 Hp through 25 HP; 125 percent of bHP
 - c. Greater than 25 HP; 115 percent of bHP
- H. Internal Vibration Isolation: Fans shall be factory mounted with manufacturer's standard vibration isolation mounting devices having a minimum static deflection of 2 inches, restrained type.
- I. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 - a. Enclosure Type: Open drip proof.
 - Motors shall meet or exceed all NEMA Standards Publication MG 1 2006 requirements and comply with NEMA Premium efficiency levels when applicable. Motors shall comply with applicable requirements of NEC and shall be UL Listed.
 - 2. Fan Motors shall be heavy duty, NEMA Premium efficient ODP, operable at 460/60/3 exceeding the EPAct efficiency requirements.

- Direct-driven fan sections shall use 2-pole (3600 rpm), 4-pole (1800 rpm), or 6-pole (1200 rpm) motors, NEMA Design B, with Class B insulation to operate continuously at 104°F (40°C) ambient without tripping of overloads
- 4. Motors shall have a +/- 10 percent voltage utilization range to protect against voltage variation.
- J. Variable Frequency Controllers:
 - Variable frequency drives shall be provided, mounted and wired by the AHU manufacturer as indicated on the schedule and drawings. All standard and optional features shall be included within the VFD enclosure. The VFDs shall be UL listed. The listing shall allow external mounting of the VFDs.
 - 2. One VFD shall be provided per fan.
 - 3. VFDs shall be factory wired to a factory provided single point connection.

2.4 COIL SECTION

- A. General Requirements for Coil Section:
 - 1. Comply with ARI 410.
 - 2. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
 - 3. Coils shall not act as structural component of unit.
- B. Water Coil:
 - 1. Coils shall be leak tested to 200 psig air pressure underwater and designed for 300 psig working pressure. The coils shall be continuous seamless copper tube with aluminum plate fins bonded by mechanical expansion of the tubes, unless otherwise indicated.
 - 2. Fin spacing shall not exceed 12 per inch.
 - 3. Frames shall be constructed of minimum stainless steel casing with copper headers brazed to tubes and threaded connections. Both supply and return headers shall be provided with 1/8 inch NPT vent connection at top and bottom for venting and draining coil. The coils shall be arranged for the water to counter-flow in the direction of the air flow.
 - 4. Tube sheets shall be minimum stainless steel, located on each end and at a maximum of 80 inch intermediate spans with drain collars to support tubes. Return bends shall be die-formed, brazed to tubes and header and shall be seamless hard-drawn copper tubing.
 - 5. Casing channels shall be free-draining, without depressions to collect moisture and contaminants or to block fin area, and with an air bypass/water carryover arrester between the casing bottom channel and the fins.

2.5 Catalytic Air Cleaner System (TCACS):

- A. The TCACS shall be a two-part integral assembly for treatment of air by: (1) Ultraviolet Germicidal Irradiation (UVGI) using UV-C lamps and fixtures; and (2) Photocatalytic Oxidation (PCO) using titanium dioxide (TiO2) media. Assembly shall be housed in steel casing. PCO media shall be a minimum of 6" deep to ensure proper kill time.
- B. The TCACS shall contain UV-C lamps and ballasts designed specifically to provide type-C ultraviolet light with a wavelength at or near 2537 Angstroms. Lamps shall be nonozone producing. Sufficient lamps shall be provided and positioned so as to achieve a minimum coverage of 5 milliwatts per square inch of UVC light across all exposed surfaces of the PCO media.
- C. The TCACS shall consist of six-inch non-metallic PCO media pleated at one pleat per inch (nominal), with a 40-200 nanometer TiO2 coating. PCO media shall be placed perpendicular to the air stream in the unit casing. Maximum velocity across the PCO media shall be 500 feet per minute.
- D. Fixtures shall meet the UL drip proof design criteria. Component enclosures shall be constructed of galvanized steel or stainless steel to resist corrosion. Fixtures shall have been tested and recognized by UL/C-UL under Category Code ABQK (Accessories, Air Duct Mounted), UL Standards 1995.
- E. The TCACS shall be configured to operate with the scheduled voltage at 60 Hz. For line voltage applications, the TCACS shall be provided with a UL 508 listed panel for power distribution and over-current protection. UV-C lamps and fixtures shall be positioned to provide an equal distribution of UV-C energy and to minimize shadowed areas. The fixture assembly shall be designed and installed such that the sum of the lamp arc lengths in a row is a minimum of 90% of the irradiated surface's total width. The lamps shall not produce ozone.
- F. Protection of Polymeric Materials:
 - 1. All polymeric materials that come into direct or indirect (reflected) contact with UV-C light shall be tested and certified as UV-C tolerant. Any polymeric material in direct or indirect contact with UV-C light not certified as UV-C tolerant shall be completely shielded from the UV-C light using a certified UV-C tolerant material such as metal. UV-C tolerance is defined as being capable of performing its intended duty for a minimum of 20 years.
 - 2. Safety:
 - a. Access doors shall be provided at the location of each TCACS as indicated on the plans and schedule. All points of access to sections of the air handler where the TCACS may pose a risk for direct exposure shall have a mechanical interlock switch that disconnects power to the lights when the door or access panel is opened.
 - b. In addition to the mechanical interlock switch, each unit shall be equipped with an externally mounted on-off/disconnect/shut off switch that disconnects power to the TCACS. The switch shall be equipped with a lock-out/tag-out to prevent unwanted operation of the TCACS.
 - c. A viewing window shall be provided on each air handler to allow viewing of the TCACS to confirm proper operation. The viewing window shall be treated and tested to assure the UV-C energy emitted through it is below the threshold limits specified by NIOSH and ACGIH.

- d. Units shall have a safety warning label applied to the exterior of each section containing the TCACS.
- e. Complete safety, maintenance and servicing instructions for the TCACS shall be incorporated into the air handler manufacturer's standard installation, operating and maintenance manuals.

2.6 AIR FILTRATION SECTION

- A. General Requirements for Air Filtration Section:
 - 1. Comply with NFPA 90A.
 - 2. Provide minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
 - 3. Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.
 - 4. Comply with requirements of Sections 234100, PARTICULATE AIR FILTRATION and 234133, HIGH EFFICIENCY PARTICULATE FILTRATION.
- B. Filter Gage:
 - 1. 2.5-inch- diameter, diaphragm-actuated dial in plastic case.
 - 2. Vent valves.
 - 3. Black figures on white background.
 - 4. Front recalibration adjustment.
 - 5. 2 percent of full-scale accuracy.
 - 6. Range: 0- to 4.0-inch wg.
 - 7. Accessories: Static-pressure tips with integral compression fittings, 1/4-inch plastic tubing, and 2- or 3-way vent valves.

2.7 DAMPERS

- A. General Requirements for Dampers: Leakage rate, according to AMCA 500, "Laboratory Methods for Testing Dampers for Rating," shall not exceed 2 percent of air quantity at 2000-fpm face velocity through damper and 4-inch wg pressure differential.
- B. Damper Operators: Comply with requirements in Division 23 Section "Instrumentation and Control for HVAC."
- C. Electronic Damper Operators:
 - 1. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
 - 2. Electronic damper position indicator shall have visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
 - a. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
 - b. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft of damper.
 - c. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
 - d. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.

- e. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.
- 3. Coupling: V-bolt and V-shaped, toothed cradle.
- 4. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
- 5. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.
- 6. Power Requirements (Two-Position Spring Return): 24-V ac, coordinate with controls.
- 7. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
- 8. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
- 9. Temperature Rating: 40 to 104 deg F.
- 10. Run Time: 30 seconds.
- D. Zone Dampers: Two single-blade, extruded-aluminum dampers offset 90 degrees from each other on cadmium-plated steel operating rod rotating in sintered bronze or nylon bearings mounted in a single extruded-aluminum frame. Provide blade gaskets and edge seals, and mechanically fasten blades to operating rod.
- E. Outdoor- and Return-Air Mixing Dampers: Parallel-blade, extruded-aluminum dampers mechanically fastened to cadmium-plated steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.

2.8 SOURCE QUALITY CONTROL

- Fan Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.
- B. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating."
- C. Water Coils: Factory tested to 300 psig according to ARI 410 and ASHRAE 33.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances, clearances and other conditions affecting performance of the Work.

- B. Examine casing and filter media before air-handling unit installation. Reject exposed insulation materials, damaged casing and filter media that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Equipment Mounting: Install air-handling units on concrete bases using elastomeric mounts. The height of the housekeeping pad under the air handling unit with a cooling coil drain pan shall be high enough, 4" minimum, to provide a condensate trap with required trap seal. Secure units to anchor bolts installed in concrete bases. Comply with requirements for concrete bases specified in Division 03 Section. Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 - 2. Install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
- B. Arrange installation of units to provide access space around air-handling units for service and maintenance.
- C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.
- D. Interlock the air handling units with their associated exhaust fans such that when the air handling unit is de-energized for any reason, the exhaust fans are also de-energized; when the air handling unit starts, the associated exhaust fans shall also start.

3.3 CONNECTIONS

- A. Comply with requirements for piping specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to air-handling unit to allow service and maintenance.
- C. Connect piping to air-handling units with flexible connectors.
- D. Connect condensate drain pans using ASTM B 88, Type M copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction. Provide a P-trap in the condensate pan drain

connection. The distance of the outlet of the P-trap below the bottom of the condensate drain pan shall be at least 1-1/2 times the suction static pressure at the inlet of the coil to insure complete drainage of the pan.

- E. Hot- and Chilled-Water Piping: Comply with applicable requirements in Division 23 Section "Hydronic Piping." Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection. Isolation valves and flanges/unions shall be arranged to provide unobstructed access for the removal of the coil.
- F. Coordinate duct installations and specialty arrangements with schematics on Drawings and with requirements specified in Division 23 Sections "Metal Ducts" and "Air Duct Accessories."
- G. Connect duct to air-handling units with flexible connections. Comply with requirements in Division 23 Section "Air Duct Accessories."
- H. The height of the housekeeping pad under the air handling unit with a cooling coil drain pan shall be high enough, 4" minimum, to provide a condensate trap with required trap seal.
- I. The height of the housekeeping pad under the air handling unit with a cooling coil drain pan shall be high enough, 4" minimum, to provide a condensate trap with required trap seal.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. Leak Test: After installation, fill water coils with water, and test coils and connections for leaks.
 - 2. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 3. Filter Operational Test: Pressurize housing to a minimum of 3-inch wg or to designed operating pressure, whichever is higher; test housing joints, door seals, and sealing edges of filter with soapy water to check for air leaks.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Verify that shipping, blocking, and bracing are removed.
 - 3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
 - 4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
 - 5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factoryrecommended lubricants.
 - 6. Verify that zone dampers fully open and close for each zone.
 - 7. Verify that outdoor-air dampers and airflow stations open and close, and maintain minimum outdoor-air setting.
 - 8. Comb coil fins for parallel orientation.
 - 9. Verify that proper thermal-overload protection is installed for electric coils.
 - 10. Install new, clean filters.
 - 11. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.
- B. Starting procedures for air-handling units include the following:
 - 1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace fan and motor pulleys as required to achieve design conditions.
 - 2. Measure and record motor electrical values for voltage and amperage.
 - 3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.6 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

3.7 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

END OF DOCUMENT 23 7313

SECTION 23 7323 CUSTOM INDOOR CENTRAL-STATION AIR HANDLING UNITS

PART 1 - GENERAL

- 1.1 SECTION INCLUDES
 - A. Design, performance criteria, controls, and installation requirements for indoor mounted Custom Air Handling Units.
- 1.2 REFERENCES
 - A. AFBMA 9 Load Ratings and Fatigue Life for Ball Bearings
 - B. AMCA Publication 99 Standards Handbook
 - C. AMCA Standard 203 Field Performance Measurement of Fan Systems
 - D. AMCA Standard 210 Laboratory Methods of Testing Fans for Performance Rating
 - E. AMCA Standard 300 Reverberant Room Method for Sound Testing of Fans
 - F. AMCA Standard 500 Laboratory Methods for Testing of Dampers and Louvers
 - G. ARI Standard 410 Forced Circulation Air-Cooling and Air-Heating Coils
 - H. ANSI/ASHRAE Standard 111 Practices for Measurement, Testing, Adjusting and Balancing of Building HVAC Systems
 - I. ASHRAE Standard 52.1 Dust-Spot Procedures for Testing Air-Cleaning Devices
 - J. ANSI/ASHRAE Standard 52.2 Method of Testing Air-Cleaning Devices for Removal Efficiency by Particle Size
 - K. ANSI/ASHRAE 15 Safety Standard for Refrigeration Systems
 - L. ANSI/ASHRAE 62.1 Ventilation for Acceptable Indoor Air Quality
 - M. ANSI/ASHRAE 90.1 Energy Standard for Buildings Except Low-Rise Residential
 - N. ARI 1060 Performance Rating of Air to Air Energy Recovery Ventilation Equipment
 - O. ASTM A-653 Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dipped Process
 - P. ASTM B117 Standard Practice for Operating Salt Spray Apparatus
 - Q. IBC 2006-2012 International Building Code
 - R. NEMA MG1 Motors and Generators
 - S. NFPA 70 National Electric Code
 - T. NFPA 90A Standard for the Installation of Air Conditioning and Ventilating Systems
- U. UL 900 Test Performance of Air Filters
- V. UL 1995 Standard for Heating and Cooling Equipment

1.3 SUBMITTALS

- A. Submit shop drawings and product data in accordance with Division 1
- B. Submittals shall include the following:
 - 1. Dimensioned plan and elevation view drawings, including motor starter and control cabinets, required clearances, and location of all field connections.
 - 2. Cabinet material, metal thickness, finishes, insulation and accessories.
 - 3. Ladder-type schematic drawing of the power and auxiliary utility field hookup requirements, indicating all items that are furnished by the manufacturer.
 - 4. Manufacturer's performance of each unit. Selection shall indicate, as a minimum, the following:
 - a. Fan curves with system operating conditions indicated.
 - b. Certified coil performance ratings with system operating conditions.
 - c. Calculations required for base rail heights to satisfy condensate trapping requirements of cooling coil.
 - d. Filters with performance characteristics.
 - e. Rated load amp draw.
 - f. Approximate unit shipping weight.

1.4 OPERATION AND MAINTENANCE DATA

A. Include data on design, inspection and procedures related to preventative maintenance. Operation and maintenance manuals shall be submitted at the time of unit shipment.

1.5 QUALIFICATIONS

- A. Manufacturer shall be a company specializing in the design and manufacture of custom air handling equipment and in business for no less than 15 years.
- B. Each unit shall bear an ETL label, conforming to UL Standard 1995.
- C. Units shall comply with the requirements of UL 1995 and NFPA 90.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under the supervision of the owner in accordance with the manufacturers Operation and Maintenance Instructions.

1.7 SEQUENCING AND SCHEDULING

A. Coordinate work performed under this section with work performed under the separate installation contract.

1.8 WARRANTY

- A. The complete unit shall be covered by a parts only warranty issued by the manufacturer covering the first year of operation. The warranty period shall start on the date of equipment startup or six months after the date of shipment, whichever occurs first.
- B. The installing contractor shall provide labor warranty during the unit's first year of operation.

PART 2 - PRODUCTS

- 2.1 MANUFACTURER
 - A. Basis of design is ClimateCraft. To be approved, manufacturers shall meet or exceed performance and construction aspects as described and detailed herein. Requests for prior approval must be submitted 10 days prior to bid date. Submittal is to be in sufficient detail to determine equivalency. Substitution requests must originate from a bidder which is a general contractor or mechanical contractor plan record holder.

2.2 GENERAL

A. Units shall be completely factory assembled and tested with the exception of unit splits as required for shipping or installation requirements as indicated on the schedule and drawings. The equipment's cooling, heating, humidifying, ventilating, exhausting capacity and performance shall meet or exceed that shown on the schedule. Tags and decals to aid in service or to indicate caution areas shall be provided. Electrical wiring diagrams shall be attached to the control panel access doors. Operation and Maintenance manuals shall be furnished with each unit.

2.3 CABINET CONSTRUCTION

- A. Cabinets shall be constructed in a watertight and airtight manner. The manufacturer's standard cabinet construction shall result in an ASHRAE/ANSI Standard 111 Leakage Class 5 rating, or better, as measured in accordance with AMCA Standard 210. A leakage rate as a percent of airflow shall only be submitted following calculation at specific project conditions. Maximum casing leakage (cfm/100 ft² of casing surface area) = CL X P^{0.65.} Published leakage rates at generic conditions shall not be submitted.
- B. Casing deflection shall not exceed L/200 at +12.0 w.g. in all positive pressure sections and -12.0 w.g. in all negative pressure sections where L is defined as the panel span. Panels shall be designed to deflect no more than 1/200 (.0005" per inch) of span under operating design conditions when measured at the panel span. Casing shall be rated for 1% leakage at 1.5 times the operating pressure with a maximum overall pressure of 12" wc.
- C. The unit shall be constructed on a 5" welded structural tubular steel base. Base tubing shall be cold-formed carbon steel, electric resistance welded. Equipment using a die-formed sheet metal base is not acceptable. Formed intermediate cross members shall be constructed of hot rolled 12 gauge galvanized steel. After fabrication, the base frame shall be thoroughly cleaned and coated with high solids, polyamide epoxy paint system for superior corrosion resistance.

- D. Units shipped in multiple sections shall be engineered for ease of field assembly. Gasket supplied with the unit shall be a high quality weather resistant closed-cell EPDM sponge rubber. Each section shall include a permanent label to aid in proper field assembly. All gasket and necessary assembly hardware shall ship loose with unit. Floors shall be designed to deflect no more than 1/200 of span under operating conditions.
- E. Floors:
 - a. Shall be fabricated of 16 gauge G-90 galvanized steel All floor sheets shall be isolated from the base assembly with an EPDM thermal break gasket.
 - b. Floors shall be insulated with a two-part polyurethane water impervious foam insulation. If glass fiber insulation is used, a 20 gauge type 304 stainless steel under liner shall be provided.
 - c. Under liner shall also be provided when bottom of unit is used as an air tunnel. Under liner shall be fabricated of 16 gauge G-90 galvanized steel
- F. Wall and Roof Panels:
 - a. Panels shall be 2" thick double wall construction. Panel joints shall be sealed with an industrial EPDM gasket to form a water and airtight seal. Air handling manufacturers using caulk to seal panels must include an owner witnessed field leakage test. The test shall require the unit to be field design air flow tested and cabinet leak tested for 1% at 1.5 times the operating pressure.
 - b. Panels shall be individually removable for service without removing the roof or compromising the integrity of the cabinet wall. Panels shall be joined with 5/16" bolts that can be removed and refastened. Panel attachment with screws is not acceptable. All panels shall utilize thermal break construction between the exterior panel and the interior liner and between the panels and the base and roof frames.
 - c. For long term durability, exterior panels shall be a minimum 16 gauge G90 galvanized steel
 - Interior liners shall be a minimum 20 gauge G90 galvanized steel. Panel liners shall be of a single piece construction and attached to the exterior panels with a full thermal break. To allow for cleaning, no fasteners shall be used on the exposed liner surface. Single wall units are not acceptable.
- G. Insulation:
 - a. All wall and roof panels shall be insulated with an injected foam insulation with an R value of 6.6/inch. Panels shall be designed to deflect no more than 1/200 of span under operating design conditions when measured at the panel seam. Insulation shall fill the panel without voids. Panels shall have a minimum 20 gauge G90 galvanized steel
- H. Access doors shall be provided into all sections of the air-handling unit as indicated in the plan documents. Doors shall be sized as shown on plan drawings, shall be a minimum 2" thick with R13 polyurethane foam insulation and shall be double wall construction using the same material type as the corresponding section. Doors shall comply with the requirements of UL 1995 and NFPA 90. The door frame shall be 0.125" extruded 6063-T5 aluminum. Each door shall be mounted with adjustable die cast aluminum hinges. All doors and mounting frames shall incorporate a thermal break design and the doors shall seal to a replaceable extruded EPDM

sponge rubber gasket. Doors shall open against static pressure or shall include a pressure relief feature on the door latch.

- a. The door latch assembly shall consist of a roller cam compression arm with a chrome plated steel inner handle and glass fiber/nylon composite outer handle. One tool operated key operated lock shall be provided on each fan section access door. All doors shall have a minimum of two latches.
- b. A 10"x12" thermal pane viewing window with one wire mesh safety glass pane and one clear pane shall be provided. The frame shall have a no-through-metal thermal break design. Viewing windows shall be on all doors serving a lighted section. Windows on doors exposed to unit mounted UVC light shall use glass that is resistant to UVC transmission.
- I. The entire unit, including walls, roof, doors, joints, and seams shall include thermal break construction. This construction shall be supported by tested performance producing no condensation on the exterior surface when the air tunnel temperature is 50°F DB under the following exterior conditions:
 - a. (Th 50) / (Th Tdp) < 3.4
 - b. Th = Ambient dry bulb temperature (°F) external to housing
 - c. Tdp = Ambient dew point temperature (°F) external to housing

2.4 FAN ASSEMBLIES – GENERAL

A. The fan shall be of the size and type specified in the unit schedule. To assure maximum performance, fans shall be supplied by a manufacturer specializing in fan design and production.

All fan assemblies shall be designed for heavy-duty industrial applications. Fan framing assemblies shall be fabricated from structural steel electrically welded to form a rigid, integral base. Individual fan assemblies shall be independently isolated.

All fan drives shall be selected with a minimum 1.3 service factor. Sheaves shall be machined from a close grain cast iron and dynamically balanced by the manufacturer. Variable pitch sheaves shall be provided on motors from 1 to 15 horsepower. Fixed pitch sheaves shall be provided on motors larger than 15 horsepower. All V-belts shall be precision molded raw edge construction and shall be oil and heat resistant.

All motors shall be NEMA design B with Class F insulation. Electrical characteristics and horsepower shall be as specified on the project schedule. All motors shall have a minimum service factor of 1.15. Motors shall have ball bearings. Motors shall be premium efficiency ODP type and shall be factory wired to a junction box for field connection. The motor shall be located within the unit and mounted on an adjustable heavy steel base. The motor base shall be fastened securely to the structural steel framing of the fan assembly.

All fans shall meet the minimum efficiency and maximum brake horsepower values as scheduled. All fans shall be selected to operate at a point no higher than 90% of the peak static pressure rating as defined by the fan performance curve at the selected operating speed. Manufacturer must ensure maximum fan RPM is below the first critical speed. Completed assemblies including fan, motor and drive shall be dynamically balanced by the manufacturer to a 0.157 inches/second or better, filter in reading, in all three planes and at all bearing supports.

All fan assemblies shall be supplied with 2 inch deflection spring isolators in at least four appropriate points. Isolators shall be seismic rated to withstand seismic forces in excess of 1G horizontally and vertically. Spring vibration isolators shall be furnished with a heavy steel retainer, resilient grommet, and stabilizing fiber reinforced washer and shall be bolted securely to the fan assembly. Isolation springs shall be color coded for easy identification. Isolators shall be mounted to a structural angle on the fan frame assembly. Spring type thrust restraints shall be supplied on all fans which will travel horizontally more than ¼" when in operation. Springs shall be sized and adjusted so that the assembly floats when operating at design conditions. Isolator attachment to unsupported floor plate or formed sheet metal supports is not acceptable.

- B. Provide direct-drive SWSI airfoil plenum fan(s) designed for industrial duty and suitable for continuous operation. Fans shall be licensed to bear the AMCA seal for Certified Sound and Air Performance. AMCA licensed sound certification shall include both inlet and fan outlet sound power levels. Fan wheels shall be of the non-overloading backward inclined type having airfoil blades. All wheels are to have a minimum of 912 blades.
- C. Each fan shall be provided with a factory installed airflow measuring device. Airflow device to be mounted out of the direct air stream so as not to affect system static pressure or sound performance. Sensor accuracy shall be +/- 3%. Performance shall have been verified in an AMCA registered air chamber. Factory installed assembly shall include flow sensors for field connection to a transducer provided by others. and transmitter with digital display that shall provide a 4-20mA output signal.

2.5 FAN ASSEMBLIES – DIRECT DRIVE FAN ARRAY

- 1) Approved Manufacturers: ClimateCraft and Hunt Air
 - a) Fan Arrays shall be direct-drive, non-overloading SWSI plenum fans designed for industrial duty and suitable for continuous operation.
 - Fans shall be arranged in an array using one or more welded structural steel assemblies and shall be of the size and quantity specified in the unit schedule. Screwed or riveted frames are unacceptable. Fan assemblies shall be attached directly to base structural members.
 - ii) Fan wheels shall have a minimum of 12 airfoil blades for superior sound characteristics and shall be constructed of aluminum to reduce rotational weight and vibration. Fan blades shall be extruded aluminum for uniformity and improved vibration characteristics.
 - iii) Each fan and motor assembly shall be independently isolated within the structural assembly using 1 inch deflection spring isolators. Isolators shall be mounted in a three point arrangement that provides both vertical and horizontal (thrust) isolation and shall not require field adjustment. If hard mounted or rubber in shear is used in place of internal spring isolations, external isolation of the entire unit is required. Isolation system shall be seismic rated.
 - iv) A fan inertia base shall be provided or the fan structure shall exceed an equivalence of 2x mass of the total rotating parts of the fan array. Fan and motor assemblies shall be designed such that no natural frequencies exist within the operating RPM range of the fan, eliminating the need for "lockout" frequency settings in the variable speed drive. The purchasing contractor will be responsible for all costs associated with externally isolating any unit that does not include individual fan isolation.

- v) All fan arrays shall meet the minimum motor efficiency, maximum brake horsepower and total motor horsepower values scheduled. All fans shall be selected to operate at a point no higher than 90% of the peak static pressure rating as defined by the fan performance curve at the selected operating speed. Manufacturer must ensure maximum fan RPM is below the first critical speed. Fans shall be Class 2 Class 3 construction.
- vi) All fan and motor assemblies shall be dynamically balanced by the manufacturer to a maximum allowable vibration of 0.040 inches per second at design RPM and a maximum 0.080 inches per second overall vibration limit to bring the fan balance in conformance to a BV-5 Grade G1 per ANSI/AMCA 204. In addition, the manufacturer shall insure that no critical frequencies exist in the fan operating range by varying motor speed in 1Hz increments from design RPM to 50% of design RPM.

b) Motors:

- i) Electrical characteristics and horsepower shall be as specified on the project schedule.
- ii) Motors shall be Premium Efficiency per NEMA MG1 Table 12-12 ODP type, shall have NEMA Class F insulation, shall meet NEMA Standard MD-1 Inverter Duty rating and shall be designed to withstand 1600V peak voltage spikes and rise times ≥0.1 microseconds.
- iii) Motors shall have grease lubricated ball bearings designed to deliver a minimum L10 life of 250,000 hours at full load and the maximum operating RPM of the associated fan. Grease zerks and spring loaded grease relief valves shall be provided in each motor to allow easy bearing lubrication without damaging the seals due to over lubrication.
- iv) For efficient operation in a direct drive application, motors shall be capable of operating greater than 60HZ to at least the design operating speed of the fan.
- v) Each motor shall be provided with a shaft grounding device to harmlessly bleed potential induced shaft voltages to ground.
- c) Warranty
 - i) All rotating parts shall be warranted by the unit manufacturer for a full five (5) years from date of unit start-up. Parts warranties provided by third parties are not acceptable.
- d) Options
 - i) In the fan section, provide an overhead motor removal system to facilitate motor replacement.
 - (1) The assembly shall be either a manually operated winch, capable of being easily moved to any motor location or provide a structural steel I beam for mounting a trolley to assist in fan motor removal. Trolley assembly shall be provided by AHU manufacturer. The beam system shall be mounted overhead of the fan and motor. The beam system shall be supported and mounted to the unit's base support system.
- 2) Fan Array Controls:
 - A. Fan arrays shall be controlled using a common control signal, such as the duct static control signal, to modulate the fan speed.

B. Each fan array in the air handling unit shall be provided with a factory installed airflow measuring instrument. Every fan in the array will have an airflow measuring device that is guaranteed by the unit manufacturer to have no impact on the fan airflow performance and will not increase the fan sound power. The output of the airflow measurement device on each fan shall be wired by the unit manufacturer back to a central processor mounted on the cabinet exterior that will add the flow from each fan to provide a total airflow for the fan array. Using one air flow measuring device and multiplying by the number of fans provided is not acceptable due to lack of accuracy.

The central processor shall be able to detect and report a fan failure. Auxiliary contacts on the motors starters are not acceptable as fans can fail without tripping overloads. Current sensors wired into the central processors can be utilized. Acceptable manufactures are: AccAMP series ACSX, CR Magnetics model CR439, Greenheck FMS, NK Technologies series AS1.

Piezometric volume taps with pressure transducers are acceptable. Transducer accuracy shall be 1% of pressure reading from full scale down to 10% of full scale reading to improve accuracy to less than 0.5% of calculated flow from 100%-30% of flow. The square root linearization and conversion of the pressure signal to flow shall be done at the central processor. Acceptable pressure transducers are: MatrixMonitor™ Fan Sensor, Omega PX656, Greenheck FMS, Setra Model 239.

C. Unit manufacturer shall supply and mount for each fan in the air handler a tri-axial accelerometer used to measure fan vibration. The output of each accelerometer shall be processed in real time through a FFT processor to provide frequency domain vibration for each fan. The vibration readings shall be reported in velocity and available for a frequency range that is a minimum of 3 times the operational speed of the fans. The system shall be capable of checking the fan vibration against user selectable vibration limits and reporting when those limits are exceeded. Each fan vibration sensor will be tied back to the airflow monitor where the individual fan vibration levels can be displayed on the local keypad display and the alarms and data can be transmitted to the BMS through the MODBUS communication link. Acceptable manufacturers are: MatrixMonitor™ Fan Sensor, IMI Sensors model 685B, Greenheck FMS, Metrix Instrument Co. model 440.

2.6 UNIT SOUND POWER

- A. Fan sound power levels (dB) for the unit shall not exceed values as specified on the equipment schedule.
- B. Unit manufacturer shall provide certified inlet, supply and casing radiated, sound power levels based on the final unit configuration.

2.7 COILS

A. Provide complete coil section(s) with service access door(s) as shown on the plan drawings. Coil connections shall extend through the section casing for ease of installation. Coil connections must be sealed from both the inside and exterior surfaces of the panel with the sleeve of the inner seal covering the pipe within the depth of the panel, all to minimize leakage and condensation. An integral galvanized steel air seal which completely seals around the coil casing and extends to the unit pressure bearing surface shall be provided. Air seals/safing materials that are mechanically fastened to the inner liner of the cabinet only shall be constructed of 16 gage materials to match the material type in the appropriate section and shall be gasketed and have fasteners every 3 inches.

- B. Multiple, "stacked" coil arrangements must be constructed so as to allow independent removal of any coil without the removal of another within the coil bank.
- C. All coils shall meet or exceed the capacities specified on the mechanical schedule and all water coil performances shall be certified in accordance with the AHRI Forced Circulation Air Heating and Air Cooling Coil certification program which is based on AHRI Standard 410. Face velocities shall not exceed those specified on the mechanical schedule.
- D. All cooling coil sections shall include a double sloped drain pan constructed from 304L stainless steel. All corners shall be welded watertight. Coils shall rest on stainless steel supports. The pan shall have a minimum pitch of 2" from high point to the bottom of the drain outlet connection, providing at least a 1/8" per foot slope. The drain pan shall be insulated with a 2-part sprayed on polyurethane, water impervious foam. Insulation shall be applied to the entire under side of the drain pan and coil section base assembly. If multiple stacked coils are used, intermediate drain pans are required. Intermediate pans shall be insulated and drained with 3/4" copper down-comers to the main pan.
- E. Water coils shall be of a staggered tube design with high efficiency die formed corrugated plate-type fins for maximum performance. All coils shall be tested with 400 psig compressed air under clear water. Coils shall be designed to operate at 300 psig internal pressure and up to 250°F. Tubes shall be 5/8" diameter, seamless 0.020" wall copper, mechanically expanded into full drawn fin collars for a continuous compression bond over the full finned length for high efficiency performance. Coil casings shall be a minimum 16 gauge stainless steel. Coil casing reinforcements shall be required for fin lengths over 42". Coil fins shall be 0.0075" thick copper. Coils shall be serviceable using 0.25" M.P.T. drain and vent taps on the supply and return headers. Threaded seamless red brass coil connections shall be brazed to copper supply and return headers.

2.8 FILTERS

A. Provide complete filter section(s) with filter racks and service access door(s) as shown on the plan drawings. Holding frames provided for medium efficiency applications will be either upstream or downstream accessible. Holding frames provided for high efficiency applications will be upstream accessible, only. Holding frames shall be constructed from heavy gauge galvanized steel and shall be equipped with polyurethane foam gaskets. Frames shall be installed with vertical stiffeners and appropriate frame-to-frame sealant to provide a rigid leak tight assembly. An integral air seal which completely seals around the filter frame assembly and extends to the unit pressure bearing surface shall be provided. Air seals/safing materials that are mechanically fastened to the inner liner of the cabinet only shall be gasketed and have fasteners every 3 inches

Filter fasteners shall be capable of being installed without the requirement of tools, nuts or bolts. The holding frame shall be designed to accommodate standard size filters with the application of the appropriate type fastener. The filter rack shall be designed to use standard 24"x24" and 12"x24" filters only. Odd sized filters are not allowed. Holding frame assemblies shall be sized to meet or exceed the face area specified by the mechanical schedule.

B. Angle filter racks shall be provided. Angle racks shall be fabricated from a minimum 16 gauge galvanized steel. Angle racks shall be applied in medium efficiency filter applications, and will be either upstream or side accessible. Upstream access filter racks shall have one central access cover per row of filters, centered in the unit for easy access. Side access filter racks over 72" long shall include an angle center reinforcement support. Filter racks shall be sized

to meet or exceed the area specified in the mechanical schedule. The filter rack shall be designed to use standard 24"x20" and 12"x20" filters only. Odd sized filters are not allowed.

- C. Gauges
 - a. A Magnehelic differential pressure gauge shall be provided factory installed for measuring the pressure drop across each filter bank-single stage The gauge shall be a diaphragm-actuated dial type, 4¾" O.D., with white dial, black figures and graduations and pointer zero adjustment.
- D. Medium efficiency pleated filters shall be 2" thick, 30% efficient MERV 8 as rated by ASHRAE Standard 52.1 test methods. Filter media shall be of the non-woven cotton fabric type. The filter shall have an average efficiency of 25-30%.
- E. High efficiency rigid filters shall be 12" deep, high capacity, pleated, totally rigid disposable type. Filters shall consist of micro-fine synthetic media laminated to a non-woven backing, media support grid, contour stabilizers and enclosing frame. The filter media shall have an average efficiency of 95% as rated by ASHRAE 52.1 test methods. The enclosing frame shall be constructed of galvanized steel. It shall be constructed and assembled in such a manner that a rigid and durable enclosure for the filter pack is affected. The enclosing frame shall be equipped with protective diagonal support members on both the entering air and air leaving sides of the filters.

2.9 HEPA FILTERS

- A. Provide complete filter section with filter racks and service access door(s) as shown on the plan drawings. Holding frames shall consist of holding frame section, constructed of not less than 14-gauge galvanized steel of all welded construction and reinforcing flanges as an integral part of the holding frame to preclude the possibility of deflection of the sealing flange. Annular based dimples and mounting holes, gasket seals gel-pack seals, receptacle guides, and removable swing bolt assemblies shall all be an integral part of the holding frame. Frames shall be installed with vertical stiffeners and appropriate frame-to-frame sealant to provide a rigid leak tight assembly. An integral air seal which completely seals around the filter frame assembly and extends to the unit pressure bearing surface shall be provided. The design of the frames shall be such that it will accommodate nominal 24"x24" HEPA filters (23%" x 23%" actual) in either 6" or 12" depth.
- B. HEPA filters shall meet or exceed 99.97%, MERV 17 efficiency on 0.3 micron particles when tested with thermally generated D.O.P. in accordance with the latest industry and military standards. The clean static pressure shall be no greater than 1.0" W.G. when operated at rated airflow. The media shall be glass paper. Filters shall be factory constructed and assembled of galvanized steel frames, corrugated aluminum separators and 100% solid resin sealant.

2.17 ULTRAVIOLET GERMICIDAL IRRADIATION LAMPS

- A. Ultraviolet germicidal irradiation (UVGI) lamps shall be provided. Lamps shall be installed such that the entire leaving face of the cooling coil(s) and the drain pan are exposed to the light in accordance with the GSA 2003 Facilities Standard, HVAC Systems and Components. Fixtures shall have been tested, Listed and labeled as UL/C-UL under Category Code ABQK (Accessories, Air Duct Mounted), UL Standards 153, 1598 & 1995, respectively.
- B. Each lamp shall contain no more than 8 milligrams of mercury, consistent with current environmental practices, while producing the specified output at 500 fpm in temperatures of

 55° F - 135°F. Useful lamp life shall be 9,000 hours with no more than a 20% output loss at the end of one year of continuous use.

C. Any windows with visual access to the light shall use protective UVC resistant glass. Access to any section with visual access to UVC light shall include automatic kill switches to deenergize the lamps.

2.18 ELECTRICAL POWER AND CONTROLS

A. Unit operating voltage shall be 460V, 3 phase, 60Hz. All wiring and electrical equipment supplied by the manufacturer shall conform to and be installed in accordance with the requirements of UL1995.

Provide copper wires, bus bars, and fittings throughout, except internal wire of the control transformer may be aluminum if copper termination is provided. Identify power supply terminals with permanent markers. The maximum temperature of terminals shall not exceed 167°F (75°C) when the equipment is tested in accordance with its rating. Wiring shall be run in plated flexible metal conduit.

Mount a permanent nameplate on the unit to display the manufacturer, serial number and model number, date of manufacture, horsepower, current rating and voltage.

B. Each section provided with a service access door, or as indicated on the plan drawings, shall be equipped with a vapor proof mini-fluorescent service light. All lights shall be completely installed and wired to individual a single toggle 60 minute timer switch. All switches shall be wired to the unit control panel. All switch boxes shall include a GFCI convenience receptacle. Lights shall be wired so they are functional whether the main power disconnect is in the on or off position.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in strict accordance with manufacturer's requirements, shop drawings, and Contract Documents.
- B. Adjust in alignment on concrete foundations, sole plates or other supporting structure. Level, grout, and bolt in place.
- C. Coordinate electrical installation with electrical contractor.
- D. Coordinate controls with control contractor.
- E. Provide all appurtenances required ensuring a fully operational and functional system.

3.2 START-UP

A. Equipment start-up is to be supervised by the unit manufacturer or a manufacturer-certified service organization. Physical connections and start-up are provided by the installing contractor. The start-up engineer shall conduct such operating tests as required to ensure that the unit is operating in accordance with design. Complete testing of all safety and emergency control devices shall be made. The start-up engineer shall submit a written report to the owner and manufacturer containing all test data recorded as required above and a letter certifying that the unit is operating properly.

B. Provide complete Operation & Maintenance Manuals with descriptive literature, model, and serial number of all equipment, performance data, manufacturer's instructions for operating and maintenance, lubrication recommendation and schedule, and winter shutdown procedure.

END OF SECTION

SECTION 23 8150 VARIABLE REFRIGERANT FLOW VRF HVAC EQUIPMENT

PART 1 – GENERAL

1.1 SYSTEM DESCRIPTION

Provide variable capacity, heat pump air conditioning system equivalent to Carrier/Toshiba Electric VRF (Variable Refrigerant Flow) supplied by Carrier Puerto Rico & Caribbean.

1.2 QUALITY ASSURANCE

- A. The units shall be listed by Electrical Testing Laboratories (ETL) and bear the ETL label.
- B. All wiring shall be in accordance with the National Electrical Code (N.E.C.).
- C. The units shall be manufactured in a facility registered to ISO 9001 and ISO14001 which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).
- D. All units must meet or exceed the 2010 Federal minimum efficiency requirements and the ASHRAE 90.1 efficiency requirements for VRF systems. Efficiency shall be published in accordance with the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Standard 1230.
- E. A full charge of refrigerant for the condensing unit shall be provided in the condensing unit.

1.3 DELIVERY, STORAGE AND HANDLING

A. Unit shall be stored and handled according to the manufacturer's recommendation.

1.4 CONTROLS

- A. The control system shall consist of a low voltage communication network of unitary built-in controllers with on-board communications and a web-based operator interface. A web controller with a network interface card shall gather data from this system and generate web pages accessible through a conventional web browser on each PC connected to the network. Operators shall be able to perform all normal operator functions through the web browser interface.
- B. System controls and control components shall be installed in accordance with the manufacturer's written installation instructions.
- C. Furnish energy conservation features such as optimal start, night setback, request-based logic, and demand level adjustment of overall system capacity as specified in the sequence.
- D. System shall provide direct and reverse-acting on and off algorithms based on an input condition or group conditions to cycle a binary output or multiple binary outputs.
- E. Provide capability for future system expansion to include monitoring and use of occupant card access, lighting control and general equipment control.
- F. System shall be capable of email generation for remote alarm annunciation.

G. Control system start-up shall be a required service to be completed by the manufacturer or a duly authorized, competent representative that has been factory trained in Carrier/Toshiba Electric controls system configuration and operation. The representative shall provide proof of certification for Carrier/Toshiba Electric Controls Applications Training indicating successful completion of no more than two (2) years prior to system installation. This certification shall be included as part of the equipment and/or controls submittals. This service shall be equipment and system count dependent and shall be a minimum of one (1) eight (8) hour period to be completed during normal working hours.

PART 2 – WARRANTY

- 2.1 The units shall be covered by the manufacturer's limited warranty for a period of one (1) year parts and seven (7) year compressor to the original owner from date of installation.
- 2.2 All manufacturer technical and service manuals must be readily available for download by any local contractor should emergency service be required. Registering and sign-in requirements which may delay emergency service reference are not allowed.

PART 3 – PRODUCTS

3.1 OUTDOOR UNIT

- A. General:
 - The heat pump variable refrigerant flow system is a two-pipe system consisting of a single or multiple outdoor units, multiple indoor units of various types and capacities, individual or central indoor unit controls with on/off temperature settings, all connected by fully insulated refrigerant lines utilizing factory supplied, fully insulated, branching kits. Indoor units are connected to condensate piping that shall be terminated to the nearest drain point.
 - 2. The system shall be fully capable of providing heating or cooling as requested by the individual indoor zones that can consist of single or multiple indoor units. The heating priority shall be the default factory setting and can be changed to cooling, majority or a single zone priority.
 - 3. The maximum number of connected indoor units shall not exceed 64.
 - 4. The total connected indoor unit capacity shall range between 50 and 150% of the outdoor unit capacity based on indoor unit type & size selected.
 - 5. Units shall be listed by ETL (Engineering Testing Laboratory) and be evaluated in accordance with UL standard 1995, 4th. edition.
 - 6. Units shall be listed in the AHRI directory.
 - 7. All units shall meet the Federal minimum efficiency standards and be tested per AHRI 1230 Standard.
 - 8. Units shall be shipped in one piece and shall be stored and handled per unit manufacturer's recommendations.

- 9. Units shall be supplied with a base rail that provides openings for moving the unit by fork truck or rigging the unit by crane.
- B. Equipment:
 - 1. General:

Factory-assembled, single piece air-cooled outdoor unit. Contained within the unit enclosure shall be all factory wiring, piping, controls, and the multiple inverter-driven twin rotary compressors.

- a. The maximum sound pressure rating for a single module shall not exceed 64 dBA sound pressure in cooling and 65 dBA in heating and for multiple modular systems the sound pressure numbers should not exceed 68 dBA and 69 dBA. Sound pressure ratings are measured at a distance of 3 ft out and 4 ½ ft up from the side of the outdoor unit.
- b. The outdoor unit shall include an oversized accumulator and a liquid tank for proper heating performance while allowing the indoor unit PMV (pulse modulating valve) metering device to shut off completely when a zone is satisfied.
- c. The outdoor unit shall be protected by a high-pressure switch, high-pressure sensor, low-pressure sensor, fusible plug, PC board, and inverter overload protector.
- d. The outdoor unit shall be capable of operating in cooling mode down to 14F ambient air temperature and down to -13 F wet bulb ambient air temperature in heating.
- e. The outdoor unit shall include a total oil management system that balances oil between compressors within a module, replenishes compressor oil to the compressors in a module from the oil separator if required, and allows oil and refrigerant to move between multiple modular units if required, even if one of the units is not running.
- 2. Unit Cabinet:
 - a. Unit cabinet shall be constructed of pre-coated steel, finished on both inside and outside.
 - b. Unit access panels shall be removable with minimal screws and shall provide full access to the compressors, fan, and control components.
 - c. Compressors shall be isolated in a compartment and have an acoustic wrap to assure quiet operation.
 - d. The outdoor unit control panel shall include a sliding window to access adjustable controls and an LED display for setup and diagnostics.
 - e. Unit cabinet shall be capable of withstanding 500-hour salt spray test per Federal Test Standard No. 141 (method 6061).
- 3. Fans:
 - a. Outdoor fan shall discharge air vertically and be driven by a DC inverter variable speed motor with 64 steps that is capable of running down to 60 rpm.

- b. Outdoor fan motor shall be totally-enclosed with permanently-lubricated bearings.
- c. Motor shall be protected by internal thermal overload protection.
- d. Fan blade shall be non-metallic and shall be statically and dynamically balanced.
- e. Outdoor fan shall be protected by a raised non metallic protective grille.
- 4. Compressors:
 - a. Each outdoor unit module shall be equipped with two inverter-driven twin rotary compressors with full range control to an accuracy of $\Box 0.1$ Hz.
 - b. Compressor shall be totally enclosed in the machine compartment.
 - c. Compressors shall be equipped with factory mounted crankcase heaters.
 - d. Internal overloads shall protect the compressor from over-temperature operation.
 - e. Motor shall be suitable for operation in an R-410A refrigerant atmosphere.
 - f. Compressor assembly shall be installed on rubber vibration isolators.
 - g. To maximize compressor reliability, multiple compressors within a module shall be started and operated in variable patterns to ensure equal run time on all compressors.
 - h. To ensure maximum efficiency throughout the system operation range, no compressor is required to run at maximum speed under any condition.
- 5. Outdoor Coil:
 - a. Coil shall be constructed of aluminum fins mechanically bonded to seamless copper tubes, which are cleaned, dehydrated, and sealed.
 - b. The coil configuration shall be 4-sided and fully separated from the machine compartment for more effective heat transfer and sound isolation.
 - c. The coil fins shall have a factory-applied corrosion resistant blue-fin finish.
- 6. Controls and Safeties:

Operating controls and safeties shall be factory selected, assembled, and tested. The minimum control functions shall include the following:

- a. Controls:
 - i. Compressor speed to match the refrigerant flow and capacity with the system requirements.
 - ii. Outdoor fan motor speed for higher efficiency and lower sound.
 - iii. Oil control for improved system reliability and comfort
 - iv. Pulse modulating valve control for precise control of the refrigerant distribution and accurate capacity management to avoid starving any units.

- v. Control of compressor staging to maximize reliability and minimum run time on all compressors.
- vi. Module control of compressor operation, compressor speed, and outdoor heat exchanger surface to maximize efficiency and sound level and reliability across the entire operating range of the system.
- vii. Control of the outdoor heat exchanger surface (main vs sub heat exchangers) for maximum efficiency and comfort.
- 7. Safeties: The following safety devices shall be part of the condensing unit:
 - a. High-pressure switch
 - b. Fuses
 - c. Crankcase heater
 - d. Fusible plug
 - e. Overcurrent relay for the compressor
 - f. Thermal protectors for compressor and fan motor
 - g. Compressor time delay
 - h. Oil recovery system
 - i. Oil level sensor
 - j. Overcurrent sensor
 - k. Compressor suction and discharge temperature sensor
 - I. Compressor suction and discharge pressure sensor
- 8. Electrical Requirements:
 - a. All sizes shall utilize 208/230-3-60 or 460-3-60 (V-Ph-Hz) field power supply.
 - b. Multiple systems shall have separate field power supply to each module.
 - c. Two-core, standard, shielded low voltage cable shall be required for communication between outdoor and indoor unit.
 - d. All power and control wiring must be installed per NEC and all local electrical codes.
- 9. Refrigerant Piping and Line Lengths:
 - a. Piping connections shall be from the front or the bottom of the unit. The unit shall be capable of operating with maximum connected refrigerant line lengths up to 3281 (ft) actual based on total system capacity and refrigerant amount.
 - b. The outdoor unit shall have the ability to operate with a maximum height of 230 ft between the outdoor and the lowest indoor unit.

- c. The maximum distance between the outdoor unit and the furthest fan coil shall not exceed 623 ft actual or 771 ft equivalent. No line size changes or oil traps shall be required.
- d. The system shall be capable of operating when the height difference between the upper and the lower fan coil is 131 ft.
- 10. Auxiliary Refrigerant Components:
 - a. All field-supplied copper tubing connecting the outdoor unit to the indoor unit shall use factory-supplied branching kits consisting of either Y joints or headers to ensure even refrigerant flow.
 - b. To ensure piping flexibility, the system shall allow having Y joints or headers downstream of another header.
 - c. When combining multiple modules, and in order to maximize efficiency and comfort, a 3/8-in. oil balance line shall be used to allow the flow oil and refrigerant between the two units, even when one of the units is not running.

3.2 HIGH STATIC DUCT INDOOR UNIT

- A. General
 - 1. Indoor, high static ducted, direct-expansion indoor units are matched with a heat pump or a heat recovery VRF (variable refrigerant flow) outdoor unit.
 - Indoor, direct-expansion, high static ducted fan coils. Unit shall be complete with a coil, fan driven by DC motor, PMV (pulse modulating valve), piping connectors, electrical controls, microprocessor control system, integral temperature sensing, and hanging brackets.
- B. Unit Cabinet:
 - 1. Cabinet shall be constructed of zinc-coated steel and configured for rear return.
 - 2. The cabinet shall have knockout for fresh air intake.
- C. Fans:
 - 1. The fan shall be of the multi-blade type with performance designed to match the coil performance.
 - 2. The fan shall be statically and dynamically balanced to ensure low noise and vibration and capable of up to 1.0 in. wg external static pressure.
- D. Coil:
 - 1. Coil shall be copper tube with aluminum fins and galvanized steel tube sheets.
 - 2. Fins shall be bonded to the tubes by mechanical expansion and specially coated for enhanced wettability.

- 3. A drip pan under the coil shall have a factory-installed drain connection for hose attachment to remove condensate.
- E. Motors:
 - 1. Motors shall be totally enclosed, permanently lubricated ball bearing with inherent overload protection.
- F. Controls:
 - 1. The system shall be microprocessor controlled to maintain precise room temperature and minimum power consumption.
 - 2. The controls system shall employ a genetic algorithm for temperature control.
- G. Any of the following user interface accessories shall be compatible with the unit.
 - 1. Wired Remote Controller
 - a. Wired remote controller shall communicate over two-core shielded wire up to 1640 ft. It shall be capable of controlling groups of up to 8 indoor units. It shall be able to operate as a primary or secondary controller when two remote controllers are connected to a single indoor unit or group. The system shall be able to be configured so that the return air (TA) can be sensed at the unit, at the remote controller or through a remote sensor. The local controller shall minimally be able to control On-OFF, set point, mode, and be able to display system generated error codes.
 - 2. Central Controller (Smart Manager)
 - a. Central controller shall communicate over two-core shielded wire up to 6500 ft and use existing indoor outdoor communication protocol to communicate. A single central controller shall be capable of controlling up to 128 indoor units individually with capability to program maximum of 10 setups for each day. It shall be able to create 2 indoor unit line-ups with 64 units on each line. It shall provide master, weekly, four special day and monthly scheduling feature. During schedule operation, user can set the power status (ON/OFF), operation mode, temperature setup, and remote control operation, restricted / allowed, return back and ventilation operation. It shall provide a web interface for remote monitoring, control, and scheduling. It shall be capable of monitoring energy consumption for each tenant and generate monthly billing reports.
 - 3. Central Controller (Touch Screen)
 - a. Central controller shall communicate over two-core shielded wire up to 1600 ft and use existing indoor outdoor communication protocol to communicate. A single central controller shall be capable of controlling up to 512 indoor units individually with capability to program maximum of 20 setups for each day. It shall provide master, weekly, five special day and monthly scheduling feature. In addition, an optional digital I/O interface shall provide alarm, fire and locking signals. It shall provide a web interface for remote monitoring, control, and scheduling. It shall be capable of monitoring energy consumption for each tenant and generate monthly billing reports.

- 4. Building Management Systems
 - a. The system shall be able to be controlled by BACnet* or LonWorks† protocols either directly or through an external gateway.
- 5. BACnet and LonWorks shall be able to control:
 - a. ON / OFF
 - b. operation mode
 - c. fan speed
 - d. louver
 - e. set temperature
 - f. permit / prohibit local operation
 - g. BACnet and LonWorks shall be able to monitor:
 - h. ON / OFF
 - i. operation mode
 - j. fan speed
 - k. louver
 - I. set temperature
 - m. permit / prohibit local operation
 - n. room temperature
 - o. error status
 - p. error code
- H. The unit shall have the following functions as a minimum:
 - 1. Selectable automatic restart. After power failure the system will restart at the same operating conditions as before the failure.
 - 2. Temperature-sensing controls shall sense return air temperature at the unit or at the remote control
 - 3. Indoor coil freeze protection in both cooling and heating (reversing valve failure) modes.
 - 4. Dehumidification mode shall provide increased latent removal through total system modulation.
 - 5. Fan-only operation to provide room air circulation when no cooling is required.
 - 6. Fan speed control shall be user set to one of three speeds by using the taps on the motor.
 - 7. Indoor coil high temperature protection shall be provided to detect excessive indoor discharge temperature in heating.
 - 8. Cold blow prevention in heating.

- 9. Adjustable compensation for air stratification in heating.
- 10. Filters:
 - a. The filters shall be field supplied or purchased separately as accessory. Filter boxes shall be provided with units to allow MERV 8 filtration.
- 11. Electrical Requirements:
 - a. Indoor units are 208/230-1-60 (V-Ph-Hz).
- 12. Special Features (Accessory sold separately)
 - a. Zoning Duct, Auxiliary OA Knockout & Filter Kit

PART 4 – START UP AND INSPECTIONS

- 4.1 The VRF Manufacturer shall oversee and assist the installing contractor with the start up and commissioning of VRF equipment as outlined below. This process will be completed in two phases. Phase one shall cover the Pre-Start-Up inspection process, Phase two will cover the Physical Start-Up & Commissioning of Equipment.
 - A. All VRF System Commissioning activities shall be completed by an employee of the VRF manufacturer whose primary job responsibilities are to provide start up and commissioning of their products; sales staff or in-house support staffs are not permitted to complete this scope of work.
 - B. A factory certified representative may assist the VRF manufacturer's personnel in the completion of certain elements of work contained within this specification. Activities completed by a Factory Certified Representative shall be supervised onsite by the VRF manufacturer. Certified representatives shall not be used in lieu of the manufacturer's personnel.
 - C. The installing contractor shall have been certified by the manufacturer to install VRF systems, having attended a minimum 3- day VRF Service & Installation course at an approved training center. A copy of this certificate shall be presented as part of the VRF equipment submittal process
 - D. The installing contractor shall assist the VRF manufacturer in their completion of the system review and have available a technician with appropriate diagnostic tools, materials and equipment, as required, for the duration of the inspection process. The technician shall be fully licensed and insured to complete necessary duties as directed under the supervision of the VRF manufacturer.
 - E. Upon completion of the Equipment Start-Up & VRF Commissioning process, the VRF manufacturer shall provide a formal report outlining the status of the system, in electronic format only. Contained within this report shall be copies of all field inspection reports, required action items and status, Manufacturers design software As-Built, equipment model & serial numbers.
 - F. Completion of the Equipment Start-Up and VRF Commissioning process shall verify that the VRF system has been installed per the Engineer's design intent and complies with the VRF manufacturers engineering and installation specifications related to their equipment.

G. Compliance with federal, state and local codes as well as other authorities having jurisdictions are not part of this process and are the responsibility of the installing contractor.

H. Contact your regions Carrier/Toshiba Electric Professional Solutions Manager for information and pricing related to services required under this projects scope of work.

4.2 PRE START-UP INSPECTION

- A. Contractor shall employ the services of the VRF manufacturer to provide a comprehensive field review of the completed VRF system installation, prior to the physical start up and operation of equipment. Upon satisfaction that the system meets the VRF manufacturer's installation requirements and specifications, the contractor shall be allowed to proceed with the physical start up and operation of equipment.
- B. Prior to the pre-start-up inspection, all systems components shall be in a final state of readiness having been fully installed and awaiting inspection.
- C. The installing contractor shall provide the VRF manufacturer a copy of the electronic design file used in the design and engineering process of the system being inspected. This electronic design file shall have been completed on software approved by the specified VRF manufacturer and shall have been updated to reflect as-built conditions.
- D. The installing contractor shall have prepared the refrigeration piping systems per equipment installation and service manuals. All refrigerant piping systems, upon completion of assembly, shall have been pressurized to a minimum 600 PSI, using dry nitrogen, and held for an uninterrupted 24HR period, with acceptable change due to atmospheric conditions.
 - 1. A record of the pressure check process shall be recorded and tagged at the outdoor unit. The tag shall contain the following information: date & time of pressure check start, fill pressure, outdoor temperature at start & stop, date & time of pressure check completion, and the person's full name & company information completing the pressure check.
 - 2. The installing contractor shall engage the General Contractor as a witness of the pressure check process, confirming that all steps and procedures related to the pressure check where properly followed and that the system held the holding pressure of 600PSI for a period of 24hr hours, with acceptable change due to atmospheric conditions. Witness information, including full name, company name, title, phone number and signature shall be recorded on same pressure tag used by installing contractor.
- E. Upon completion of the 600 PSI pressure check, the system shall be evacuated to a level of 500 microns, where it will be held for a period of 1HR with no deflection. The installing contractor shall utilize the triple evacuation method per the equipment install and service manuals.
 - 1. Evacuation start & stop dates, times, and persons involved shall be recorded and tagged at the outdoor equipment.
 - 2. Installing contractor shall digitally capture a photo of the micron gauge reading, at the conclusion of the 1hr holding period, for each system and provide a copy to the VRF manufacturer. Each photo shall contain a tag providing the outdoor units Serial number.
- F. Upon the completion of the 500-micron hold, the calculated additional refrigerant charge can be added. The calculated refrigerant charge shall have been calculated using the VRF manufacturers design software.

- 1. Total refrigerant charge of the system shall be recorded and displayed at the outdoor unit by permanent means.
- G. A review of the equipment settings shall be completed, with recommendations provided to improve system performance, if applicable. Physical changes of system settings will be completed by the contractor. Electronic recording of final DIP switches shall be provided as part of the commissioning report.
- H. A comprehensive review and visual inspection shall be completed for each piece of equipment following a detailed check list, specific to the equipment being reviewed. A copy of the inspection report shall be provided as part of the manufacturers close out documentation. Any deficiencies found during the inspection process shall be brought to the attention of the installing contractor for corrective action. Any system components that are not accessible for proper inspection shall be noted as such.
- I. Indoor Equipment report shall contain
 - 1. Model & Serial Number
 - 2. Equipment location
 - 3. Equipment Tag/Identification number
 - 4. Network Address & Port Assignment
 - 5. Digital recording of equipment settings
 - 6. Mounting/support method
 - 7. Seismic restraints used
 - 8. Proper service clearance provided
 - 9. Wiring and connection points are correct
 - 10. High voltage reading(s) within acceptable range
 - 11. Low voltage reading(s) within acceptable range
 - 12. Type of Remote Controller used and its location
 - 13. Occupied space temperature sensing location
 - 14. Air temperature readings within acceptable range
 - 15. Condensate pump interlock method
 - 16. Fan E.S.P. setting
 - 17. Air Filter condition
 - 18. Height differential setting in heat mode
 - 19. Noise level acceptable
 - 20. Refrigerant pipe connected and insulated properly
 - 21. Condensate pipe connected and insulated properly
 - 22. Condition of connected ductwork
 - 23. Fresh air connected
 - 24. Humidifier connected and checked
 - 25. Review of air balance report complete

26. Other interlocked systems, i.e. baseboard heat, booster fan etc.

4.3 Physical Start-Up & Commissioning of Equipment

- A. Upon proper equipment start up by the contractor, following the manufacturers guidelines and specifications, an employee of the VRF manufacturer shall complete a review of the system performance and complete the following tasks:
- B. Check and confirm all communication addressing of system components.
- C. Check and confirm each indoor unit, individually, is properly piped and wired by commanding the indoor unit on, in either heat or cool mode and verifying proper response.
 - 1. This process shall be digitally recorded and included as part of the close out documentation.
- D. Electronically record a minimum of one-hour of operational data per refrigeration system.
- E. Electronically record selector switch positions on all indoor and outdoor equipment.
- F. The VRF manufacturer shall retain the electronically recorded data, collected during the startup and equipment commissioning process, at a designated location within the US for future reference.

4.4 Close-Out Information

A. The VRF manufacturer shall issue a System Performance report at the completion of all fieldwork. Contained within this report shall be an overview of the system performance, recommendations, field reports, all electronic data, and as-built design file.

4.5 VRF Equipment Warranty

- A. Having successfully completed the Pre-Inspection, Start-Up & Equipment Commissioning processes and fulfilling all requirements, as outlined in the VRF manufacturers Extended Warranty Process. Along with installing contractor being certified by the VRFR manufacturer to install VRF systems, having attended a minimum 3- day VRF Service & Installation course at an authorized training center.
- B. The equipment shall be provided with the following warranty per the VRF manufacturer's warranty policy:
 - 1. Compressor: 7-year part only
 - 2. Parts: 5-years part only
 - 3. Labor: no labor coverage provided by VRF Manufacturer

4.6 GENERAL

- A. The VRF manufacturer shall provide the owner's representative a minimum []-hour VRF Operation and Maintenance training class covering systems installed under this scope of work.
- B. Training program is to be provided at the time of owner occupancy.

- C. Owner shall provide a suitable location, onsite, to conduct the VRF Operation and Maintenance class.
- D. Training material shall be provided to participants in electronic format.
- E. Contact your region's Carrier/Toshiba Electric Professional Solutions Manager for information and pricing related to services required under this projects scope of work.

END OF SECTION

SECTION 23 8219 FAN COIL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.1 SUMMARY

A. This Section includes fan-coil units and accessories.

1.2 DEFINITIONS

A. BAS: Building automation system.

1.3 SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. LEED Submittals:
 - 1. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1-2004, Section 5 "Systems and Equipment."
- C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection: Wiring Diagrams: Power, signal, and control wiring.
- D. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Ceiling suspension components.
 - 2. Structural members to which fan-coil units will be attached.
 - 3. Method of attaching hangers to building structure.
 - 4. Size and location of initial access modules for acoustical tile.
 - 5. Items penetrating finished ceiling, including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - 6. Perimeter moldings for exposed or partially exposed cabinets.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 "Systems and Equipment" and Section 7 "Construction and Startup."
- C. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 "Heating, Ventilating, and Air-Conditioning."

1.5 COORDINATION

A. Coordinate layout and installation of fan-coil units and suspension system components with other construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of condensing units that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Motor failure.
 - b. Coil leak.
 - 2. Warranty Period: Five years from date of Substantial Completion.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fan-Coil-Unit Filters: Furnish two spare filters for each filter installed.
 - 2. Fan Belts: Furnish one spare fan belt for each unit installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
- B. In the Fan-Coil-Unit Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include manufacturers specified.

2.2 FAN-COIL UNITS

A. Manufacturers:

1. Trane.

- B. Description: Factory-packaged and -tested units rated according to ARI 440, ASHRAE 33, and UL 1995.
- C. Coil Section Insulation: 1-inch thick, matte-finish, closed-cell foam complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.
 - 1. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
 - 2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
- D. Main and Auxiliary Drain Pans: Stainless steel. Fabricate pans and drain connections to comply with ASHRAE 62.1-2004.
- E. Chassis: Galvanized steel where exposed to moisture. Floor-mounting units shall have leveling screws.
- F. Cabinet: Steel with baked-enamel finish in manufacturer's standard paint color as selected by Architect.
 - 1. Vertical Unit Front Panels: Removable, steel, with steel discharge grille and channelformed edges, cam fasteners, and insulation on back of panel.
 - 2. Horizontal Unit Bottom Panels: Fastened to unit with cam fasteners and hinge and attached with safety chain; with cast-aluminum discharge grilles.
 - 3. Steel recessing flanges for recessing fan-coil units into ceiling or wall.
- G. Outdoor-Air Damper: Galvanized-steel blades with edge and end seals and nylon bearings; with electronic, two-position actuators.
- H. Filters: Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
 - 1. Pleated Cotton-Polyester Media: 90 percent arrestance and 8MERV.
- I. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.
- J. Fan and Motor Board: Removable.
 - 1. Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanizedsteel fan scrolls.

- Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
- 3. Wiring Termination: Connect motor to chassis wiring with plug connection.
- K. Factory, Hydronic Piping Package: ASTM B 88, Type L copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet, and outlet.
 - 1. Two or Three way, modulating control valve for chilled-water coil.
 - 2. Two or Three way modulating control valve for hot-water reheat coil.
 - 3. Hose Kits: Minimum 400-psig working pressure, and operating temperatures from 33 to 211 deg F. Tag hose kits to equipment designations.
 - a. Length: 36 inches.
 - b. Minimum Diameter: Equal to fan-coil-unit connection size.
 - 4. Two-Piece Ball Valves: Bronze body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig minimum CWP rating and blowout-proof stem.
 - 5. Calibrated-Orifice Balancing Valves: Bronze body, ball type; 125-psig working pressure, 250-deg F maximum operating temperature; with calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, threaded ends, and equipped with a memory stop to retain set position.
 - Automatic Flow-Control Valve: Brass or ferrous-metal body; 300-psig working pressure at 250 deg F, with removable, corrosion-resistant, tamperproof, selfcleaning piston spring; factory set to maintain constant indicated flow with plus or minus 10 percent over differential pressure range of 2 to 80 psig.
 - 7. Y-Pattern Hydronic Strainers: Cast-iron body (ASTM A 126, Class B); 125-psig working pressure; with threaded connections, bolted cover, perforated stainless-steel basket, and bottom drain connection. Include minimum NPS 1/2 hose-end, full-port, ball-type blowdown valve in drain connection.
 - 8. Wrought-Copper Unions: ASME B16.22.
 - 9. Risers: ASTM B 88, Type L, copper pipe with hose and ball valve for system flushing.
- L. Control devices and operational sequences are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls".
- M. DDC Terminal Controller:
 - 1. Scheduled Operation: Occupied and unoccupied periods on seven-day clock with a minimum of four programmable periods per day.
 - 2. Unoccupied Period Override Operation: Two hours.

- 3. Unit Supply-Air Fan Operation:
 - a. Occupied Periods: Fan runs continuously.
 - b. Unoccupied Periods: Fan cycles to maintain room setback temperature.
- 4. Hydronic-Cooling-Coil Operation:
 - a. Occupied Periods: Modulate control valve to maintain room temperature.
 - b. Unoccupied Periods: Close control valve.
- 5. Outdoor-Air Damper Operation:
 - a. Occupied Periods: Open damper to fixed position for 25 percent outdoor air.
 - b. Unoccupied periods: Close damper.
- N. BAS Interface Requirements:
 - 1. Interface relay for scheduled operation.
 - 2. Interface relay to provide indication of fault at the central workstation.
 - 3. Provide BACnet MS/TP or TP/ICP (Ethernet) interface for central BCS communications network for the following functions:
 - a. Adjust set points.
 - b. Fan-coil-unit start, stop, and operating status.
 - c. Data inquiry, including outdoor-air damper position, supply- and room-air temperature.
 - d. Occupied and unoccupied schedules.
- O. Electrical Connection: Factory wire motors and controls for a single electrical connection.
- P. Capacities and Characteristics: See Schedule on Drawings

2.3 DUCTED FAN-COIL UNITS

Basis of Design Product: Product name or designation or a comparable product by one of the following: 1. Trane

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive fan-coil units for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in for piping and electrical connections to verify actual locations before fan-coil-unit installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install fan-coil units level and plumb.
- B. Install fan-coil units to comply with NFPA 90A.
- C. Suspend fan-coil units from structure with elastomeric hangers. Vibration isolators are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- D. Verify locations of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above finished floor.
- E. Install new filters in each fan-coil unit within two weeks after Substantial Completion.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
 - 1. Install piping adjacent to machine to allow service and maintenance.
 - 2. Connect piping to fan-coil-unit factory hydronic piping package. Install piping package if shipped loose.
 - 3. Connect condensate drain to indirect waste:
 - a. Install condensate trap of adequate depth to seal against the pressure of fan. Install cleanouts in piping at changes of direction.
- B. Connect supply and return ducts to fan-coil units with flexible duct connectors specified in Division 23 Section "Air Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
 - 3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.5 ADJUSTING

- A. Adjust initial temperature and humidity set points.
- B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fan-coil units. Refer to Division 01 Section "Demonstration and Training."

END OF DOCUMENT 23 8219

SECTION 26 0100 BASIC ELECTRICAL REQUIREMENTS

PART1- GENERAL

1.1 GENERAL

- A. Basic Requirements: The Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.
- B. General Provisions: Provide all labor, materials, equipment, and incidentals required to make ready for use complete electrical systems as specified herein and shown on the drawings.
- C. Provide and Install: The word "provide" where used on the Drawings or in the Specifications shall mean "furnish, install, mount, connect, test, complete, and make ready for operation". The word "install" where used on the Drawings or in the Specifications shall mean "mount, connect, test, complete, and make ready for operation". Perform work required by, and in accordance with, the Contract Documents.
- D. Installation: Provide and place in satisfactory condition, ready for proper operation, raceways, wires, cables, and other material needed for all complete electrical systems required by the Contract Documents. Additional raceways and wiring shall be provided to complete the installation of the specific equipment provided. Include auxiliaries and accessories for complete and properly operating systems. Provide electrical systems and accessories to comply with the NEC, state and local codes and ordinances. It is the intent of these Specifications that the electrical systems be suitable in every way for the use intended. Material and work which is incidental to the work of this Contract shall be provided at no additional cost to the Contract.
- E. Field Connections: Provide field connections to remote equipment and control panels provided under other Divisions of these Specifications. Provide raceway, wire, and interconnections between equipment, transmitters, local indicators, and receivers. Provide 120V and low voltage surge protection equipment in accordance with Section 26 4313 at equipment as required. Install field connections to "packaged" equipment provided under other Divisions of these Specifications.

1.2 SCOPE OF WORK

- A. General: Provide labor, materials, permits, inspections and re-inspection fees, tools, equipment, transportation, insurance, temporary protection, temporary power and lighting, supervision and incidental items essential for proper installation and operation of the Electrical systems indicated in the Contract Documents. Provide materials not specifically mentioned or indicated but which are usually provided or are essential for proper installation and operation of the Electrical systems indicated systems indicated in the Contract documents.
- B. Notices: Give notices, file plans, pay fees, and obtain permits and approvals from authorities having jurisdiction. Include all fees in the Bid Price.

1.3 INTERPRETATION OF DRAWINGS

A. General: The Drawings are diagrammatic and are not intended to show exact locations of Raceway runs, outlet boxes, junction boxes, pull boxes, etc. The locations of equipment,

appliances, fixtures, Raceways, outlets, boxes and similar devices shown on the Drawings are approximate only. Exact locations shall be determined and coordinated in the field. The right is reserved to change, without additional cost, the location of any outlet within the same room or general area before it is permanently installed. Obtain all information relevant to the placing of electrical work and in case of interference with other work, proceed as directed by the Architect.

- B. Discrepancies: Notify the Architect of any discrepancies found during construction of the project. The Architect will provide written instructions as to how to proceed with that portion of work. If a conflict exists between the Contract Documents and an applicable code or standard, the most stringent requirement shall apply.
- C. Wiring: Each three-phase circuit shall be run in a separate Raceway unless otherwise shown on the Drawings. Unless otherwise accepted by the Architect, Raceway shall not be installed exposed. Where circuits are shown as "home-runs" all necessary fittings, supports, and boxes shall be provided for a complete raceway installation.
- D. Layout: Circuit layouts are not intended to show the number of fittings, or other installation details. Connections to equipment shall be made as required, and in accordance with the accepted shop and manufacturer's setting drawings.
- E. Coordination: Coordinate final equipment locations with drawings or other disciplines. Layout before installation so that all trades may install equipment in available space. Provide coordination as required for installation in a neat and workmanlike manner.

1.4 EQUIPMENT SIZE AND HANDLING

- A. Coordination: Investigate each space in the structure through which equipment must pass to reach its final location. If necessary, ship the equipment in sections of specific sizes to permit the passing through the necessary areas within the structure.
- B. Handling: Equipment shall be kept upright at all times. When equipment has to be tilted for ease of passage through restricted areas during transportation, the manufacturer shall be required to brace the equipment suitably, to insure that the tilting does not impair the functional integrity of the equipment.

1.5 RECORD DRAWINGS

- A. Production: The Contractor shall provide two (2) sets of black or blue line on white drawings to maintain and submit record "As-Built Documents". Label each sheet of the Record Document set with "Project Record Documents" with company name of the installing contractor in stamped or printed letters. One set shall be maintained at the site and at all times be accurate, clear, and complete. These drawings shall be available at all times to the Architect's field representatives.
- B. Recording: Record information concurrent with construction progress. Make entries within 24 hours upon receipt of information. The "As-Built" drawings shall accurately reflect installed electrical work specified or shown on the Contract Documents.
- C. Completion: At the completion of the Work, transfer changes with a colored pencil onto the second set and submit to the Architect. The "As-Built" drawings shall be made available to the Architect to make the substantial completion punch list.
- D. Final: Upon Contractor's completion of the Engineer's final punch list, transfer all "As-Built" conditions and all requirements by the Engineer to a reproducible set of drawings

and REVIT files. Submit drawings and REVIT disks for review and acceptance. The Contractor shall provide updated disks which include final As-Built conditions.

1.6 ABBREVIATIONS

A. Abbreviations: The following abbreviations or initials may be used:

A/C	Air Conditioning
AC	Alternating Current
ABV CLG	Above Ceiling
ADA	Americans with Disabilities Act
AF	Ampere Frame
AFF	Above Finished Floor
AFG	Above Finished Grade
AHU	Air Handler Unit
AIC	Amps Interrupting Capacity
AL	Aluminum
AMP	Ampere
ANSI	American National Standards Institute
ASA	American Standards Association
AT	Ampere Trip
ATS	Automatic Transfer Switch
AUX	Auxiliary
AWG	American Wire Gauge
BC	Bare Copper
BIL	Basic Impulse Level
BMS	Building Management System
BRKR or BKR	Breaker
CAB	Cabinet
С	Conduit or Raceway
СВ	Circuit Breaker
СВМ	Certified Ballast Manufacturers
CCTV	Closed Circuit Television
СКТ	Circuit
CLEC	Clock Equipment Cabinet
CLG	Ceiling
CO	Conduit or Raceway Only
COAX	Coaxial Cable
COND	Conductor
CONN	Connection
CPU	Central Processing Unit
CRT	Cathode Ray Terminal (Video display terminal)
СТ	Current Transformer
CU	Copper
CW	Cold Water
DC	Direct Current
DDC	Direct Digital Control
DEG	Degree
DISC	Disconnect
DO	Draw Out
DN	Down
DPST	Double Pole Single Throw
EMT	Electrical Metallic Tubing
EO	Electrically Operated
EOL	End of Line Resistor

EWC	Electric Water Cooler
FAAP	Fire Alarm Annunciator Panel
FACP	Fire Alarm Control Panel
FCU	Fan Coil Unit
FLA	Full Load Amperes
	Factory Mutual
GF	Ground Fault
GFCI	Ground Fault Circuits Interrupter
GND	Ground
HOA	Hand-Off-Automatic
HORIZ	Horizontal
HP	Horsepower
IC	Intercom
ICU	Intensive Care Unit
IEEE	Institute of Electrical and Electronic Engineers
IES	Illuminating Engineering Society
IMC	Intermediate Metallic Raceway
IN	Inches
IT	Instantaneous Trin
	Insulated Power Cable Engineers Association
	Insulated Fower Cable Engineers Association
	Theycond Circular Mille
KVA	Kilo-volt-Amps
KW	Kilowatts
LBS	Pounds
LED	Light Emitting Diode
LT	Light
LTD	Long Time Delay
LTT	Long Time Trip
LTG	Lighting
MAX	Maximum
МСВ	Main Circuit Breaker
MCC	Motor Control Center
MCP	Motor Circuit Protector
MIC	Microphone
MIN	Minimum
MIO	Main Luge Only
	Mounted
	Mountied
MIG	Mounting
MUX	Multiplex (Transponder) Panel
MVA	Mega Volt Amps
N	Neutral
NC	Normally Closed
NEC	National Electrical Code
NECA	National Electrical Contractors Association
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NIC	Not in Contract
NF	Non Fused
NL	Non Linear
NO	Number or Normally Open
#	Number
 Ø	Phase
	Overload
	Overivau

OSHA Occupational Safety and Health Administra	tion
	lion
PB Pullbox	
PIV Post Indicator Valve	
DNI Danal	
DD Dair	
PWN POwer Factor	
DT Detential Transformer	
PI Polenilai Hansionnei	
PVC Polyvinyichionide	
REF Reiligerator	
RGC of GRC Rigid Galvanized Raceway	
RMS Root-Mean-Square	
RPM Revolutions Per Minute	
SCA Short Circuit Amps	
SD Smoke Detector	
SEC Secondary	
S/N Solid Neutral	
SPKR Speaker	
SPST Single Pole Single Throw	
SST Solid State Trip	
ST Short Time Trip	
STD Short Time Delay	
SW Switch	
SWGR Switchgear	
SWBD Switchboard	
TEL Telephone	
TTB Telephone Terminal Board	
TTC Telephone Terminal Cabinet	
TVEC Television Equipment Cabinet	
TYP Typical	
UL Underwriters Laboratories	
UON Unless Otherwise Noted	
V Volt	
VFD Variable Frequency Drive	
VSD Variable Speed Drive	
W Wire	
WP Weatherproof	
XFMR Transformer	

1.7 CODES, FEES, AND STANDARDS

- A. Application: The codes, standards and practices listed herein generally apply to the entire project and specification sections. Other codes, standards or practices that are more specific will be referenced within a particular specification.
- B. Requirements: All materials and types of construction covered in the specifications will be required to meet or exceed applicable standards of manufacturer, testing, performance, and installation according to the requirements of UL, ANSI, NEMA, IEEE, and NEC referenced documents where indicated and the manufacturer's recommended practices. Requirements indicated on the contract documents that exceed but are not contrary to governing codes shall be followed.
- C. Compliance and Certification: The installation shall comply with the governing state and local codes or ordinances. The completed electrical installation shall be inspected and certified by applicable agencies that it is in compliance with codes.
- D. Applicability: The codes and standards and practices listed herein, and their respective dates are furnished as the minimum latest requirements.
 - 1. US Virgin Islands.
- E. Utility Company: Comply with latest utility company regulations.
- F. Building Code: International Building Code 7th Edition (2020).
- G. Standards: American Society of Mechanical Engineers:
 - 1. ASME-A17.1 (2010) Elevator Code, plus Interpretations to date.
- H. Labels: Materials and equipment shall be new and free of defects, and shall be U.L. listed, bear the U.L. label or be labeled or listed with an approved, nationally recognized Electrical Testing Agency. Where no labeling or listing service is available or desired for certain types of equipment, test data shall be submitted to validate that equipment meets or exceeds available standards.
- I. NFPA: National Fire Protection Association (NFPA) Standards shall include but not be limited to the following:

NFPA-13	(2016)	Standard for the Installation of Sprinkler Systems
NFPA-20	(2016)	Standard for the installation of Stationary Pumps for Fire Protection
NFPA-70	(2017)	National Electrical Code
NFPA-72	(2016)	National Fire Alarm Code
NFPA-75	(2017)	Standard for the Protection of Electronic Computer/Data
	(0040)	Processing Equipment
NFPA-90A	(2018)	Standard for the Installation of Air Conditioning and Ventilating Systems
NFPA-92	(2015)	Standard for Smoke Control Systems
NFPA-96	(2017)	Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations
NFPA-99	(2018)	Health Care Facilities
NFPA-101	(2018)	Life Safety Code
NFPA-110	(2016)	Standard for Emergency and Standby Power Systems
NFPA-111	(2016)	Standard for Stored Electrical Energy Emergency and Standby Power Systems
NFPA-780	(2017)	Installation of Lightning Protection Systems

1.8 SUPERVISION OF THE WORK

A. Supervision: Provide one field superintendent who has had a minimum of four (4) years previous successful experience on projects of comparable sizes, type and complexity. The Superintendent shall be present at all times when work is being performed. At least one member of the Electrical Contracting Firm shall hold a State Master Certificate of Competency.

1.9 COORDINATION

- A. General: Compare drawings and specifications with those of other trades and report any discrepancies between them to the Architect. Obtain from the Architect written instructions to make the necessary changes in any of the affected work. Work shall be installed in cooperation with other Trades installing interrelated work. Before installation, Trades shall make proper provisions to avoid interferences in a manner approved by the Architect.
- B. Provide all required coordination and supervision where work connects to or is affected by work of others, and comply with all requirements affecting this Division. Work required under other divisions, specifications or drawings to be performed by this Division shall be coordinated with the Contractor and such work performed at no additional cost to Owner including but not limited to electrical work required for:
 - 1. Door hardware
 - 2. Sliding or Automatic Doors
 - 3. Interior and Exterior Signage
 - 4. Mechanical, Plumbing and Fire Protection Divisions of the Specifications
 - 5. Technology Division of the Specifications
 - 6. Landscape Architect drawings
 - 7. Millwork Design Drawings and Shop Drawings
 - 8. Medical Equipment Drawings
 - 9. Communication and Technology (IT) Drawings
- C. Obtain set of Contract Documents from Owner's Authorized Representative or Contractor for all areas of work noted above and include all electrical work in bid whether included in Division 26 Contract Documents or not.
- D. Secure approved shop drawings from all required disciplines and verify final electrical characteristics before roughing power feeds to any equipment. When electrical data on approved shop drawings differs from that shown or called for in Construction Documents, make adjustments to the wiring, disconnects, and branch circuit protection to match that required for the equipment installed.
- E. Damage from interference caused by inadequate coordination shall be corrected at no additional cost to the Owner.
- F. Adjustments: Locations of raceway and equipment shall be adjusted to accommodate the work with interferences anticipated and encountered. Determine the exact routing and location of systems prior to fabrication or installation.
- G. Priorities: Lines which pitch shall have the right of way over those which do not pitch. For example, plumbing drains shall normally have the right of way. Lines whose elevations cannot be changed shall have the right of way over lines whose elevations can be changed.
- H. Modifications: Offsets and changes of direction in raceway systems shall be made to maintain proper headroom and pitch of sloping lines whether or not indicated on the drawings. Provide elbows, boxes, etc., as required to allow offsets and changes to suit job conditions.
- I. Replacement: Work shall be installed in a way to permit removal (without damage to other parts) of other system components provided under this Contract requiring periodic replacement or maintenance. Raceway shall be arranged in a manner to clear the openings of swinging overhead access doors as well as ceiling tiles.

- J. Layout: The Contract Drawings are diagrammatic only intending to show general runs and locations of raceway and equipment, and not necessarily showing required offsets, details and accessories and equipment to be connected. Work shall be accurately laid out with other Trades to avoid conflicts and to obtain a neat and workmanlike installation, which will afford maximum accessibility for operation, maintenance and headroom.
- K. Contract Conflicts: Where discrepancies exist in the Scope of Work as to what Trade provides items such as starters, disconnects, flow switches, etc. such conflicts shall be coordinated between the divisions involved. It is the intent of the Contract Documents that all work shall be provided complete as one bid price.
- L. Drawing Conflicts: Where drawing details, plans or specification requirements are in conflict and where sizes of the same item run are shown to be different within the contract documents, the most stringent requirement shall be included in the Contract. Systems and equipment called for in the specification or as shown on the drawings shall be provided as if it was required by both the drawings and specifications. Prior to ordering or installation of any portion of work, which appears to be in conflict, such work shall be brought to Architect's attention for direction as to what is to be provided.
- M. It is the responsibility of this Contractor to coordinate the exact required location of floor outlets, floor ducts, floor stub-ups, etc. with Owner's Authorized Representative and Interior Designer (and receive their approval) prior to rough-in. Locations indicated in Contract Documents are only approximate locations.
- N. The Contract Documents describe specific sizes of switches, breakers, fuses, raceways, conductors, motor starters and other items of wiring equipment. These sizes are based on specific items of power consuming equipment (heaters, lights, motors for fans, compressors, pumps, etc.). Coordinate the requirements of each load with each load's respective circuitry shown and with each load's requirements as noted on its nameplate data and manufacturer's published electrical criteria. Adjust circuit breaker, fuse, Raceway, and conductor sizes to meet the actual requirements of the equipment being provided and installed and change from single point to multiple points of connection (or vice versa) to meet equipment requirements. Changes shall be made at no additional cost to the Owner.
- O. Working Clearances: Minimum working clearances about electrical equipment shall be as referenced in the applicable edition NEC Article 110, and shall include equipment installed in ceiling spaces.

1.10 COORDINATION STUDY

- A. Specified Manufacturers: All panelboard and circuit breakers shall be of the manufacturer and type specified herein, and as indicated on the drawings or the Coordination Study. Any discrepancies or conflicts in specified equipment shall be brought to the attention of the engineer during bid, for formal clarification.
- B. Substitutions: Alternate manufacturers (i.e. other than the Basis of Design) will not be permitted.

PART 2 - PRODUCTS

2.1 MATERIALS

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 121505 Basic Electrical Requirements Section 26 0100 - 8

- A. Specified Method: Where several brand names, make or manufacturers are listed as acceptable each shall be regarded as equally acceptable, based on the design selection but each must meet all specification requirements. Where a manufacturer's model number is listed, this model shall set the standard of quality and performance required. Where no brand name is specified, the source and quality shall be subject to Engineer's review and acceptance. Where manufacturers are listed, one of the listed manufacturers shall be submitted for acceptance. No other substitutions will be permitted.
- B. Certification: When a product is specified to be in accordance with a trade association or government standard requested by the Engineer, Contractor shall provide a certificate that the product complies with the referenced standard. Upon request of Engineer, Contractor shall submit supporting test data to substantiate compliance.
- C. Basis of Bid: Each bidder represents that his bid is based upon the manufacturers, materials, and equipment described in the Contract Documents.
- D. Space Requirements: Equipment or optional equipment shall conform to established space requirements within the project. Equipment which does not meet space requirements, shall be replaced at no additional expense to the Contract. Modifications of related systems shall be made at no additional expense to the Contract. Submit modifications to the Architect/Engineer for acceptance.

2.2 SHOP DRAWINGS

- A. General: Shop drawings shall be submitted for every item listed within the Submittals section each individual specification section. One copy shall be submitted to the engineer prior to ordering equipment. Refer to Basis of approval paragraph.
- B. Responsibility: It is the Contractors responsibility to provide material in accordance with the plans and specifications. Material not provided in accordance with the plans and specifications shall be removed and replaced at the Contractors expense.
- C. Official Record: The shop drawing submittal shall become the official record of the materials to be installed. If materials are installed which do not correspond to the record submittal they shall be removed from the project without any additional cost or delays in construction completion.
- D. Information: The shop drawing record submittal shall include the following information to the extent applicable to the particular item;
 - 1. Manufacturer's name and product designation or catalog number.
 - 2. Standards or specifications of ANSI, ASTM, ICEA, IEEE, ISA, NEMA, NFPA, OSHA, UL, or other organizations, including the type, size, or other designation.
 - 3. Dimensioned plan, sections, and elevations showing means for mounting, raceway connections, and grounding, and showing layout of components.
 - 4. Materials and finish specifications, including paints.
 - 5. List of components including manufacturer's names and catalog numbers.
 - 6. Internal wiring diagram indicating connections to components and the terminals for external connections.
 - 7. Manufacturer's instructions and recommendations for installation, operation, and maintenance.
 - 8. Manufacturers recommended list of spare parts.
 - 9. Provide 1/2" = 1'-0" enlarged electrical room layout drawings for all electrical rooms. All equipment shall be indicated at actual size of equipment being provided. All dimensions and required working clearances shall be shown.

- E. Coordination Study: This project has been designed and coordinated (electrical distribution system) utilizing the specified manufacturer(s). Refer to Specification Section 26 0100 paragraph 1.12 for additional requirements.
- F. Preparation: Prior to submittal, shop drawings shall be checked for accuracy and contract requirements. Shop drawings shall bear the date checked and shall be accompanied by a statement that the shop drawings have been examined for conformity to Specifications and Drawings. This statement shall also list discrepancies with the Specifications and Drawings. Shop drawings not so checked and noted shall be returned to Contractor unreviewed.
- G. Basis of Review: Approval is only for general conformance with the design concept of the project and general compliance with the information given in the contract documents. Contractor is responsible for quantities, dimensions, fabrication processes, and construction techniques.
- H. Responsibility: The responsibility that dimensions are confirmed and correlated with proper coordination of other trades shall be included as part of the Contract Documents. The responsibility and the necessity of providing materials and workmanship required by the Specifications and Drawings which may not be indicated on the shop drawings shall be included as part of the Contract Documents. The Contractor is responsible for any delays in job progress occurring directly or indirectly from late submissions or resubmissions of shop drawings, product data, or samples.
- I. Ordering Equipment: No material shall be ordered or shop work started until the Engineer has officially received the shop drawings record submittal and has formally released the Contractor for submittal requirements.
- J. Brochure Requirements: Submit Technical Information Brochures at the start of construction or no later than 30 days after Award of the Contract. Brochure shall be via electronic submission in .pdf format for all required submittals. Paper-based submittals will not be accepted.
- K. Contractor's Review: Review the brochures before submitting to the Engineer. No request for payment shall be considered until the brochure has been reviewed, stamped and submitted for review.
- L. Title Drawings: Title drawings to include identification of project and names of Architect-Engineer, Engineer, Contractors, and/or supplier, data, number sequentially and indicate in general;
 - 1. Fabrication and Erection dimensions.
 - 2. Arrangements and sectional views.
 - 3. Necessary details, including complete information for making connections with other work.
 - 4. Kinds of materials and finishes.
 - 5. Descriptive names of equipment.
 - 6. Modifications and options to standard equipment required by the contract.
 - 7. Leave blank area, size approximately 4 by 2-1/2 inches, near title block (for Engineer's stamp imprint).
 - 8. In order to facilitate review of shop drawings, they shall be noted, indicating by cross-reference the contract drawings, notes, and specification paragraph numbers where items occur in the contract documents.
 - 9. See specific sections of specifications for further requirements.

- M. Technical Data: Submit technical data verifying that the item submitted complies with the requirements of the specifications. Technical data shall include manufacturer's name and model number, dimensions, weights, electrical characteristics, and clearances required. Indicate optional equipment and changes from the standard item as called for in the specifications. Provide drawings, or diagrams, dimensioned and in correct scale, covering equipment, showing arrangement of components and overall coordination.
- N. Same Manufacturer: In general, relays, contactors, starters, motor control centers, switchboards, panelboards, dry type transformers, disconnect switches, circuit breakers, manual motor starter switches, etc., shall be supplied and manufactured by the same manufacturer. This requirement shall apply to same type of electrical components specified in other Divisions.

2.3 EQUIPMENT, MATERIALS, AND SUPPORTS

- A. General: Each item of equipment or material shall be manufactured by a company regularly engaged in the manufacturer of the type and size of equipment, shall be suitable for the environment in which it is to be installed, shall be approved for its purpose, environment, and application, and shall bear the UL label.
- B. Installation Requirements: Each item of equipment or material shall be installed in accordance with instructions and recommendations of the manufacturer, however, the methods shall not be less stringent than specified herein.
- C. Required Accessories: Provide all devices and materials, such as expansion bolts, foundation bolts, screws, channels, angles, and other attaching means, required to fasten enclosures, raceways, and other electrical equipment and materials to be mounted on structures which are existing or new.
- D. Protection: Electrical equipment shall at all times during construction be adequately protected against mechanical injury or damage by the elements. Equipment shall be stored in dry permanent shelters. If apparatus has been damaged, such damage shall be repaired at no additional cost or time extension to the Contract. If apparatus has been subject to possible injury, it shall be thoroughly cleaned, dried out and put through tests as directed by the Manufacturer and Engineer, or shall be replaced, if directed by the Engineer, at no additional cost to the Contract.

2.4 IDENTIFICATION OF EQUIPMENT

A. General: Electrical items shall be identified as specified in the Contract Documents. Such identification shall be in addition to the manufacturer's nameplates and shall serve to identify the item's function and the equipment or system, which it serves or controls. Refer to Identification Section of the specifications for additional information.

2.5 CONCRETE PADS

- A. General: Provide reinforced concrete pads for floor mounted electrical equipment. Unless otherwise noted, pads shall be nominal four (4) inches high and shall exceed dimensions of equipment being set on them, including future sections, by six (6) inches on all sides, except when equipment is flush against a wall, then the side or sides against the wall shall be flush with the equipment. Chamfer top edges 1/2". Trowel surfaces smooth. Reinforce pads with #5 reinforcing bars at 24" centers each way, unless specifically detailed on drawings.
 - 1. Paint (finish) all vertical edges with OSHA approved hazard yellow paint.

2.6 SURFACE MOUNTED EQUIPMENT

A. General: Surface mounted fixtures, outlets; cabinets, panels, etc. shall have a factoryapplied finish or shall be painted as accepted by Engineer. Raceways and fittings, where allowed to be installed surface mounted, shall be painted to match the finish on which it was installed. Paint shall be in accordance with other applicable sections of these specifications.

2.7 CUTTING AND PATCHING

- A. Core Drilling: The Contractor shall be responsible for core drilling as required for work under this section, but in no case shall the Contractor cut into or weld onto any structural element of the project without the written approval of the Architect.
- B. Cutting and Patching: Cutting, rough patching and finish patching shall be provided as specified in the contract documents. Cutting and patching shall be performed in a neat and workmanlike manner. Upon completion, the patched area shall match adjacent surfaces.
- C. Openings and Sleeves: Locate openings required for work performed under this section. Provide sleeves, guards or other accepted methods to allow passage of items installed under this section.
- D. Roof Penetration: All roof penetrations shall adhere to architectural specifications, details and requirements. Roof penetrations are to be waterproofed in such a manner that roofing guarantees are fully in force. Roof penetrations shall be coordinated with other Trades to ensure that roof warranty is not invalidated.

2.8 SLEEVES AND FORMS FOR OPENINGS

- A. Sleeves: Provide sleeves for Raceways penetrating floors, walls, partitions, etc. Locate necessary slots for electrical work and form before concrete is poured. Watertight sleeves shall be line seal type WS. Fire rated partition sleeves shall be mild steel. Sleeves shall be Schedule 40 PVC or galvanized rigid steel unless specifically noted otherwise. Size shall be one standard diameter larger than pipe being installed or of a larger diameter to below 1/4" minimum clearance.
- B. Forms: Provide boxed out forms for Raceway penetrations only where allowed by the Architect. Fill opening after Raceway installation, with equivalent material.

2.9 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. General: Thoroughly instruct the Owner's Representative, to the complete satisfaction of the Architect and Engineer, in the proper operation of all systems and equipment provided. The Contractor shall make all arrangements, via the Architect, as to whom the instructions are to be given in the operation of the systems and the period of time in which they are to be given. The Architect shall be completely satisfied that the Owner's Representative has been thoroughly and completely instructed in the proper operation of all systems and equipment before final payment is made. If the Architect determines that complete and thorough instructions have not been given by the Contractor to the Owner's Representative, then the Contractor shall be directed by the Architect to provide whatever instructions are necessary until the intent of this paragraph of the Specification has been complied with.
- B. Submittals: Submit to the Architect for approval electronic copies of of instructions for the installation, operation, care and maintenance of equipment and systems, including instructions for the ordering and stocking of spare parts for equipment installed under this contract. The lists shall include part number and suggested suppliers. Each set shall also include an itemized list of component parts that should be kept on hand and where such parts can be purchased.
- C. Information Requirements: Information shall indicate possible problems with equipment and suggested corrective action. The electronic file shall be indexed for each type of equipment. Each section shall be clearly divided from the other sections. A sub index for each section shall also be provided.
- D. Instructions: The instructions shall contain information deemed necessary by the Architect and include but not limited to the following:
 - 1. Introduction:
 - a. Explanation of Manual and its use.
 - b. Summary description of the Electrical Systems.
 - c. Purpose of systems.
 - 2. System:
 - a. Detailed description of all systems.
 - b. Illustrations, schematics, block diagrams, catalog cuts and other exhibits.
 - 3. Operations:
 - a. Complete detailed, step by step, sequential description of all phases of operation for all portions of the systems, including start up, shutdown and balancing. Include posted instruction charts.
 - 4. Maintenance:
 - a. Parts list and part numbers.
 - b. Maintenance and replacement charts and the Manufacturer's recommendations for preventive maintenance.
 - c. Trouble shooting charts for systems and components.
 - d. Instructions for testing each type of part.
 - e. Recommended list of on-hand spare parts.
 - f. Complete calibration instructions for all parts and entire systems.
 - g. General and miscellaneous maintenance notes.

- 5. Manufacturer's Literature:
 - a. Complete listing for all parts.
 - b. Names, addresses and telephone numbers.
 - c. Care and operation.
 - d. All pertinent brochures, illustrations, drawings, cuts, bulletins, technical data, certified performance charts and other literature with the model actually furnished to be clearly and conspicuously identified.
 - e. Internal wiring diagrams and Engineering data sheets for all items and/or equipment furnished under each Contract.
 - f. Guarantee and warranty data.

2.10 SERVICE AND METERING

- A. Company: The utility company serving this project is Duke Energy (Duke) which will be referred to as the Utility Company herein.
- B. Codes: Install a complete system in accordance with the latest edition of the National Electrical Code and the latest regulations of governing local, State, County and other applicable codes, including the Utility Company requirements.

2.11 TEMPORARY LIGHT AND POWER

- A. Capacity: Provide capacity from temporary service provided by the general contractor. Make arrangements with the general contractor for temporary service and pay all related expenses. Temporary light and power shall be provided constantly during the project dependent upon Owner's safety requirements.
- B. Lighting: Temporary light shall be based on the equivalent of (1) 28 watt, 4' fluorescent lamp covering each 1,000 square foot of floor area in the building. Each room 100 square foot and over shall have a minimum of one 28 watt, 4' fluorescent lamp with guards, or equivalent light source. Provide power for motors up to 3/4 horsepower only. Provisions are to be made for electric welders, if required.
- C. Outlets: Provide outlets located at convenient points so that extension cords of not over fifty (50) feet will reach work requiring artificial light or power.
- D. Other Connections: Contractors of other trades shall furnish their own cords and sockets, as may be required for their work and shall also pay for cost of temporary wiring of construction offices and shanties used by them.
- E. New Fixtures: Permanently installed lighting fixtures may be used for temporary lighting at the Contractor's option only after the respective architectural ceiling system has been installed and completed. Installation prior to ceiling installation is not permitted.
- F. Wiring: Temporary electrical work shall be furnished and installed in conformity with the National Electrical Code and in accordance with the requirements of the local ordinances and shall be maintained in a workmanlike manner throughout their entire construction period and shall be removed after installation of the permanent electrical systems. Extension cords shall be GFCI protected or shall be fed from GFCI circuit breakers.

PART 3 - EXECUTION

3.1 WORKMANSHIP

- A. General: The installation of materials and equipment shall be performed in a neat, workmanlike and timely manner by an adequate number of craftsmen knowledgeable of the requirements of the Contract Documents. They shall be skilled in the methods and craftsmanship needed to produce a quality level of workmanship. Personnel who install materials and equipment shall be qualified by training and experience to perform their assigned tasks.
- B. Acceptable Workmanship: Acceptable workmanship is characterized by first-quality appearance and function, conforming to applicable standards of building system construction, and exhibiting a high degree of quality and proficiency which is judged by the Architect as equivalent as or better than that ordinarily produced by qualified industry tradesmen.
- C. Performance: Personnel shall not be used in the performance of the installation of material and equipment that, in the opinion of the Architect, are deemed to be careless or unqualified to perform the assigned tasks. Material and equipment installations not in compliance with the Contract Documents, or installed with substandard workmanship and not acceptable to the Architect, shall be removed and reinstalled by qualified craftsmen, at no change in the contract price.

3.2 PROTECTION AND CLEAN UP

- A. Protection and Restoration: Suitably protect equipment provided under this Division during construction. Restore damaged surfaces and items to "like new" condition before a request for substantial completion inspection.
- B. Handling: Materials shall be properly protected and Raceway openings shall be temporarily closed by the Contractor to prevent obstruction and damage. Post notice prohibiting the use of systems provided under this Contract, prior to completion of work and acceptance of systems by the Owner's representative. The Contractor shall take precautions to protect his materials from damage and theft.
- C. Safeguards: The Contractor shall furnish, place and maintain proper safety guards for the prevention of accidents that might be caused by the workmanship, materials, equipment or systems provided under this contract.
- D. Cleanup: Keep the job site free from debris and rubbish. Remove debris and rubbish from the site and leave premises in clean condition on a daily basis.

3.3 SYSTEMS GUARANTEE

A. General: Provide a one-year guarantee. This guarantee shall be by the Contractor to the Owner for any defective workmanship or material, which has been provided under this Contract at no cost to the Owner for a period of one year from the date of substantial completion of the System. The guarantee shall include lamps, for ninety days after date of Substantial Completion of the System. Explain the provisions of guarantee to the Owner at the "Demonstration of Completed System".

3.4 FINAL OBSERVATION

A. General: Work shall be completed, and forms and other information shall be submitted for acceptance one week prior to the request for final observation of the installation.

3.5 SPECIAL CONSIDERATIONS

A. Comply with special requirements imposed at site by Owner. This may include badging of employees, prohibition of smoking, special working hours, or special working conditions associated with the hospital's Infection Control Risk Assessment (ICRA) policies.

END OF SECTION 26 0100

CERTIFICATE OF COMPLETED DEMONSTRATION MEMO

<u>Note to Contractor</u>: Do not submit this form at the time Technical Information Brochure is submitted. Submit five copies of information listed below for checking at least one week before scheduled completion of the building. After information has been accepted and inserted in each brochure, give the Owner a Demonstration of the Completed Electrical Systems and have the Owner sign five copies of this form. Provide one signed copy for each brochure. After this has been done, a written request for a final inspection of the System shall be made.

Re:

(Name of Project)

(Division Number and Name)

This memo is for the information of all concerned that the Owner has been given a Demonstration of the Completed Electrical Systems on the work covered under this Division. This conference consisted of the system operation, a tour on which all major items of equipment were pointed out, and the following items were given to the Owner;

- (a) Owner's copy of Technical Information Brochure containing approved submittal sheets on all items, including the following; (To be inserted in the Technical Information Brochure after the correct tab).
 - (Ĭ) Maintenance Information published by manufacturer on equipment items.
 - (2) Printed Warranties by manufacturers on equipment items.
 - (3) Performance verification information as recorded by the Contractor.
 - (4) Check-out Memo on equipment by manufacturer's representative.
 - (5) Written operating instructions on any specialized items.
 - (6) Explanation of the one-year guarantee on the system.
- (b) "As-Built" conditions as described in the record drawing specifications.
- (c) A demonstration of the System in Operation and of the maintenance procedures which shall be required.

(Name of General Contractor)

By:

(Authorized Signature, Title & Date)

(Name of SubContractor)

By:

(Authorized Signature, Title & Date)

Brochure, Instruction, Prints, Demonstration & Instruction in Operation Received:

(Name of Owner)

By:____

(Authorized Signature, Title, Date)

cc: Owner, Architect, Engineer, Contractor, Sub Contractor and General Contractor (List names as stated in cc: above)

SECTION 26 0500 TESTS AND PERFORMANCE VERIFICATION

PART1- GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work specified in this section.

1.2 DESCRIPTION

- A. Time: Perform verification work as required to show that the System is operating correctly in accordance with contract documents and manufacturer's literature. All verification shall be done after 3-day full operational period.
- B. Submission: Submit check out memos and completed testing results of all systems, cable, equipment, devices, etc., for acceptance prior to being energized or utilized.

1.3 QUALITY ASSURANCE

- A. Compliance: Testing shall comply to the following standards;
 - 1. NEMA
 - 2. ASTM
 - 3. NETA
 - 4. ANSI C2
 - 5. ICEA
 - 6. NFPA

PART 2 - TESTS

2.1 EQUIPMENT

- A. Instruments: Supply all instruments required to read and record data. Calibration date shall be submitted on test reports. All instruments shall be certified per NETA standards.
- B. Adjustments: Adjust system to operate at the required performance levels and within all tolerances as required by NETA Standards.

2.2 APPLICATIONS

- A. Switchboards, Panelboards and Mechanical Equipment Feeders: After feeders are in place, but before being connected to devices and equipment, test for shorts, opens, and for intentional and unintentional grounds.
- B. Cables 600 Volts or Less: Cables 600 volts or less in size #1/0 and larger shall be meggered using an industry approved "megger" with 1000V internal generating voltage. Readings shall be recorded and submitted to the Engineer for acceptance prior to energizing same. If values are less than recommended NETA values notify Engineer. Submit 5 copies of tabulated megger test values for all cables.
- C. Main circuit breakers and feeder circuit breakers 200 amps and greater shall be tested using primary injection testing as per NETA Specifications. Reports to be submitted as

substantial completion shall include manufacturer's time current curve number and trip time.

1. On-site injection testing with AHCA field inspector shall be provided for both the building main service and generator service breakers. Refer to section 26 2413 for additional requirements.

2.3 MOTORS

- A. Procedure: Test run each motor, (5 HP) and larger. Tabulate and submit electronic copies of the Test Information at substantial completion for final inspection. Refer to form at the end of this Section.
- B. Provisions: With the system energized, line-to-line voltage and line current measurements shall be made at the motors under full load conditions. The condition shall be corrected when measured values deviate plus or minus 10% from the nameplate ratings.
- C. Insulation: Test the insulation resistance's of all motor windings to ground with an appropriate test instrument as recommended by the motor manufacturer, before applying line voltage to the motors. If these values are less than the manufacturer's recommended values, notify the contractor providing the motor for correction before initial start up.
- D. Power Factor: Check power factor of all motors (5 HP) and larger while driving its intended load, and at all operating speeds.
- E. Electrode Ground: The resistance of electrodes (main service, generators, transformer, etc.) shall not exceed 5 ohms and shall be measured by The Contractor before equipment is placed in operation. Testing shall be performed on all grounding electrode installations. Testing shall be 2 point method in accordance with IEEE Standard 81. Submit all ground test readings to the Engineer in tabulated format at substantial completion.

2.4 EQUIPOTENTIAL GROUND

- A. Equipotential Ground: Test all metal conductive surfaces likely to become energized within patient care areas. Test all large conductive surfaces likely to become energized within a volume defined as 6 foot from the patient bed horizontally or 7 foot 6 inches vertically.
 - 1. Large metal surfaces not likely to be energized, which do not require testing:
 - a. Window frames
 - b. Door frames
 - c. Floor drains
 - d. Moveable metal cabinets
 - 2. Test Method:
 - a. Use impedance and voltage measurements
 - b. Utilize established ground bus or ground bar in panel serving area.
 - c. Measure voltage from reference point to conductive surfaces and all receptacle ground contacts.
 - d. Measure impedance between reference point and receptacle ground contacts.
 - e. Check for proper polarity.

- f. Identify the reference ground for each room on the ground test report. Provide a blue dot label with a permanent adhesive backing located on the bottom center of the reference ground outlet cover.
- 3. Maximum Acceptable Values:
 - a. Voltage: 20 mV plus or minus 20 percent
 - b. Impedance: 0.1 ohm plus or minus 20 percent
 - c. Quiet ground impedance: 0.2 ohm plus or minus 20 percent
- 4. Equipment:
 - a. Millivolt meter with 1 Kohm impedance and proper frequency response, in accordance with NFPA 99.
 - b. Polarity tester
- 5. Ground Test Report. Complete ground test report included at the end of this specification section, and make available copies of such to engineer and inspecting authority at final inspection.

2.5 DRY TYPE TRANSFORMERS

- A. Required Factory Tests: Required factory tests shall be as follows;
 - 1. Ratio
 - 2. Polarity
 - 3. Losses:
 - (1) No load
 - (2) Full load
 - 4. Resistance Measurements
 - 5. Impedance
 - 6. Temperature
 - 7. Impulse Strength
 - 8. Sound Level
 - 9. Exciting Current
 - 10. Low-frequency Dielectric Strength
 - 11. ANSI Point and Curve
- B. Submission: Submit test results with shop drawings.

2.6 EMERGENCY SYSTEM

A. General: Submit emergency system tests in accordance with NFPA 110. Refer to Specification Section 26 2313, 263213 and 263600 and for additional testing information.

PART 3 - EXECUTION

3.1 SUBMITTALS

- A. Cable Test Report: Submit Cable Test Report in electronic form.
- B. Transformer Test Report: Indicate comparative data of ANSI and NEMA Standards. Indicate all characteristic values as specified herein. Certified copies of tests on electrically duplicate units are acceptable.

- C. Check Out Memos: Complete all information on forms at the end of this specification, project information, and certificate of completed demonstration memo. Submit data for examination and acceptance prior to final inspection request.
- D. Tabulated Data: Submit data in electronic form with names of the personnel who performed the test.
- E. Final: Submit accepted memos before a request for final inspection.

3.2 QUANTITIES

A. Quantity: Submit check-out memo in electronic form for each major item of equipment. Insert accepted memos in each brochure with the performance verification information and submittal data.

END OF SECTION 26 0500

FACILITY NAME: _____ PROJECT NAME: _____ AHCA LOG NO.

DATE: _____TESTED BY:

MAXIMUM TEST INTERVALS: NAME: GENERAL CARE - 12 MOS. CRITICAL CARE - 6 MOS. COMPANY: WET LOCATIONS - 12 MOS.

GROUND TEST REPORT

TYPE METER USED AND EXTERNAL NETWORK IF USED: NOTE: MAXIMUM READINGS PERMITTED - 20 MV NEW CONSTRUCTION

0.1 OHM NEW CONSTRUCTION

Room No.	AREA TYPE Description (C) = CRITICAL CARE AREA	VOLTAGE MEASUREMENT			IMPEDANCE MEASUREMENT		REMARKS - IF VOLTAGE READINGS MORE THAN 20MV IN EXISTING CONST. NOTE TESTS & INVESTIGATION REQUIRED.
	(G) = GENERAL CARE AREA	NO. OF RECEPTS.	NO. OF OTHER	MAX. READING IN MILIVOLTS	NO. OF RECEPTS.	MAX READING IN OHMS	

PROJ	ECT NAME:				
мото	OR TEST INFORMATION				
Name	of Checker:				
Date	Date Checked:				
(a)	Name and identifying mark of motor				
(b)	Manufacturer				
(c)	Model Number				
(d)	Serial Number				
(e)	RPM				
(f)	Frame Size				
(g)	Code Letter				
(h)	Horsepower				
(i)	Nameplate Voltage and Phase				
(j)	Nameplate Amps				
(k)	Actual Voltage				
(I)	Actual Amps				
(m)	Starter Manufacturer				
(n)	Starter Size				
(o)	Heater Size, Catalog No. and Amp Rating				
(p)	Manufacturer of dual-element fuse				
(q)	Amp rating of fuse				
(r)	Power Factor at Speed (For variable speed motors provide recording chart over operating range)				

TABULATED DATA

VOLTAGE AND AMPERAGE READINGS

SWITCHGEAR OR PANELBOARD

FULL LOAD AMPERAGE READINGS:

DATE

TIME

PHASE A.

Β.

C.

N.

FULL LOAD VOLTAGE READINGS:

DATE

TIME

PHASE	A TO N	A TO B
	В ТО N	A TO C
	C TO N	B TO C

NO LOAD VOLTAGE READINGS

DATE

TIME

PHASE A TO N _____ A TO B

B TO N _____ A TO C

С ТО N _____ В ТО С

_____ENGINEERS REPRESENTATIVE

_____CONTRACTORS REPRESENTATIVE

SECTION 26 0513 WIRES AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work specified of this section.

1.2 WIRES AND CABLES

A. Description: Provide a complete and continuous system of conductors as specified herein. All conductors shall be in accordance with the latest edition of the NEC.

1.3 QUALITY ASSURANCE

- A. Qualifications: Manufacturers shall be regularly engaged in the manufacture of wire systems and fittings of types and sizes required, and whose products have been in satisfactory use in similar service for not less than 5 years in the USA.
- B. Compliance: Materials shall comply with the following codes and standards, current edition as adopted by the Authority Having Jurisdiction, as they apply to the different wire types specified herein.
 - 1. UL:
 - a. 44 Thermoset-Insulated Wire and Cables
 - b. 83 Thermoplastic-Insulated Wires and Cables
 - c. 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors
 - d. 486C Splicing Wire Connections
 - e. 493 Thermoplastic-Insulated Underground Feeder and Branch Circuit Cables
 - f. 514 Standard for Fittings for Cable and Conduit
 - g. 854 Service Entrance Cables
 - h. 1581 Standard for Reference Standard for Electrical Wires, Cables, and Flexible Cords
 - 2. NFPA-70 (2011) National Electrical Code.
 - 3. Insulated Cable Engineers Association (ICEA).

1.4 SUBMITTALS

A. General: Submit product data on all different types of conductors specified, including splicing tape, and terminating/splicing lugs or connectors and cable sleeves.

PART 2 - PRODUCTS

2.1 GENERAL

A. Material: All conductors shall be copper unless noted otherwise. Where aluminum conductors are indicated (AL), they shall utilize type XHHW-2 insulation. Aluminum wire shall only be allowed for feeders 100amps in size and larger.

- B. Size and Insulation: Utilize THHN/THWN-2 insulation for branch circuits and THHN/THWN-2 or XHHW-2 insulation for feeders, unless otherwise noted. Conductors #10 AWG and smaller shall be solid, #8 AWG and larger shall be stranded. All wire shall be sized as shown on the drawings. If no size is shown, wire shall be #12 AWG, except that branch homeruns" over 100 ft. in length shall be #10 AWG for 120/208V circuits, and homeruns over 200' in length shall be #10 AWG for 277/480V circuits. Wire in vicinity of heat-producing equipment as well as all Wiring associated with isolated power systems shall be type XHHW insulation. All wiring shall be manufactured in the USA and of 98 percent conductivity. Wiring for light fixture "whips", i.e connection from branch circuit wiring to individual light fixture installations, shall be permitted to be #14AWG.
- C. Taps and Splices: All copper taps and splices in #8 AWG or smaller wire shall be fastened together by means of "wirenut" connectors (Ideal or accepted substitution). All taps and splices in wire larger than #8 AWG shall be made with compression type connectors and taped to provide insulation equal to wire. All taps and splices in manholes or in ground pull box shall be made with compression type connectors and covered with Raychem heavywall cable sleeves (type CTE or WCS) with type "S" sealant coating. Provide sleeve kits as per manufacturer's installation instructions. Keep all splices to a minimum.
- D. Color Coding, General: All power feeders, grounding conductors and branch circuits regardless of size shall be installed with fully color-coded wire with the same color used for a system throughout the building. Neutral conductors shall be striped with the corresponding phase color for phase-neutral identification. Use of tape for color-coding shall not be permitted. Unless otherwise accepted, color-code shall be as indicated in specification section 26 0553 Electrical Identification. Switchlegs shall be a different color than phase or neutral conductors.

2.2 MANUFACTURERS

A. General: All copper Branch circuit and feeder conductors shall be as manufactured by one of the following: General Cable Co., Pirelli, Rome Cable Corporation, Southwire, or American Insulated Wire Corporation.

PART 3 - EXECUTION

3.1 EXECUTION

- A. General: All NEC Class 1, non-power limited wiring shall be installed in raceways regardless of voltage rating or application. All NEC Class 2, Class 3 and power-limited circuits may be installed without raceways when located above accessible ceilings. Installation within walls or above gypsum board ceilings shall remain in conduit, unless otherwise indicated or specified under other Sections of this specification.
- B. Connections: Conductors #10 and #12 AWG shall be connected with pre-insulated spring connectors encased in a steel shell and rated at not less than 105 degrees C. A minimum of 3/8-inch skirt shall cover the bare wires. The connector shall meet with UL approval for fixture and pressure work, and shall be "Scotch Lok" Type Y, R and B electrical spring connectors as manufactured by the 3M Company or approved equal.
- C. Connector Manufacturers: Lugs and wire connectors shall be one of the following: Burndy Corporation, Thomas & Betts, Co., Appleton or ILSCO.

D. Equipment Installations: Neatly form, train and tie the cables in panelboards, cabinets, wireways, switches and equipment assemblies.

END OF SECTION 26 0513

SECTION 26 0526 GROUNDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work specified in this section

1.2 GROUNDING ELECTRODES

- A. General: Provide a grounding electrode system, as described in NEC 250, as specified herein and as indicated on plans.
- B. Ground Field / Ground Rods: The ground field shall consist of three 20 ft long vertically driven ground rods arranged in a triangular pattern spaced 30 feet apart. Additional ground rods shall be added as necessary to achieve the desired resistance. Provide one field for the hospital services and a separate ground field for the medical office building service.
- C. Main Metallic Water Pipe: The building's main metallic underground water piping shall be utilized as a grounding electrode, provided the metal pipe is installed in direct contact with the earth for a minimum of 10 feet. Bond the main metallic water service, fire protection service, and chilled water service within 5 ft. of the entrance of the water pipe into the building.
- D. Rebar: In concrete buildings, provide bond to rebar in concrete footings.
- E. Resistance: Grounding electrode resistance shall not exceed 10 ohms. Overall resistance of the entire grounding electrode system shall not exceed 5 ohms. Provide additional grounding electrodes as required to meet this value. Refer to Section 26500 for testing requirements.

1.3 GROUNDING ELECTRODE CONDUCTOR

- A. Grounding Electrode Conductor: A main grounding electrode conductor, bare copper, sized per NEC, shall be run in PVC conduit from main service equipment to the grounding electrodes. This conductor shall also be bonded to the following:
 - 1. Telecommunications service ground within 20' of the electrical service
 - 2. Lightning protection system counterpoise conductor.
 - 3. Emergency generator grounding system.
 - 4. Gas and other interior metal piping refer to NEC.

1.4 SEPARATELY DERIVED GROUNDING SYSTEMS

- A. Description: Provide a separately derived grounding system where indicated herein and as required by the National Electrical Code. Bond neutral and ground busses together.
- B. Services: Provide a separately derived grounding system for all building electrical services and step-down transformers. Neutral-ground bond shall occur in the associated transformer and at in the downstream overcurrent device.

1.5 BONDING AND EQUIPMENT GROUNDING

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 121505 Grounding Section 26 0526 - 1

- A. Description of System: In general, all electrical equipment (metallic conduit, motor frames, panelboards, etc.) shall be bonded together with a green insulated copper system grounding conductor in accordance with specific rules of Article 250 of the NEC Equipment grounding conductors through the raceway system shall be continuous from main switch ground bus to panel ground bar of each panelboard, and from panel grounding bar of each panelboard to branch circuit equipment and devices.
- B. Equipment Grounding Conductors: All raceways shall have an insulated copper system ground conductor run throughout the entire length of circuit installed within conduit in strict accordance with NEC. Grounding conductor shall be included in total conduit fill when determining conduit sizes, even though not included or shown on drawings.
- C. Redundant Grounding: In general all branch circuits shall be provided with a redundant grounding system through the use of grounding conductors and metallic conduit.
- D. Bonding: Provide bonding of the equipment grounding terminal busses of normal and essential branch circuit panelboards serving the same area with a continuous #10 AWG copper green insulated conductor, in compliance with NEC 517-14.
- E. Bonding: In addition to connections to grounding electrodes, the main service ground shall be bonded to the lightning protection system and other underground metal piping.
- F. Light Poles: All exterior light poles shall have their enclosures or hand-holes grounded directly to a separate driven ground rod at the light pole in addition to the building ground connection, via the circuit equipment ground conductor.
- G. Bushings: Provide insulated grounding bushings on all metallic feeder conduits terminated within panelboards, switchboards or enclosed overcurrent devices. Provide insulated grounding bushings on all branch circuit conduits where concentric knockouts are used.
- H. Connection to Other Systems: Provide all required grounding and bonding connections as specified herein and as required by the National Electrical Code.

1.6 SUBMITTALS

A. General: Submit product data on ground rods, ground wire, ground connectors, ground bars, and data on exothermic welds.

1.7 QUALITY ASSURANCE

A. Compliance: The entire ground system shall meet or exceed the minimum requirements NEC 250 and IEEE Std. 142 (green book).

PART 2 - PRODUCTS

2.1 GROUNDING ELECTRODE AND BONDING CONDUCTORS

- A. General: Except as specified in C below, provide UL and NEC approved types of copper with THWN, THHN, or XHHW with green insulation or green tape on black insulation the entire length of conductor not in conduit.
- B. Size: Grounding electrode conductors shall be sized as specified herein and on the drawings, but in no case shall be smaller than required by NEC 250.

C. Insulation: Conductors above ground shall be insulated, conductors run below grade shall be bare.

2.2 GROUNDING ELECTRODES

A. Ground Rods: Provide copperclad steel, 5/8 inch diameter by 20 feet long vertically driven ground rods. Use of multiple 10 feet sectional ground rods is acceptable.

2.3 CONNECTIONS

- A. Bonding: One piece mechanical lugs or wire terminals, properly sized and approved by the local authority having jurisdiction shall be used to bond ground wires together or to junction boxes and panel cabinets.
- B. Underground: All connections and bonds made underground and to building steel shall be exothermic weld type-connections.

2.4 INSPECTION WELLS

- A. Location: Provide traffic-rated inspection wells for all ground rods covered by concrete, paving, landscape material or other permanent materials that prevent access to ground rods.
- B. Description: Inspection well shall be provided with circular, flush traffic rated, grade mounted, twist lock traffic cover with the word "ground" (or similar) on the cover. Inspection test well shall allow clear access to the ground rod and exothermic weld connection of conductor to ground rod. Clearly mark ground rod locations on as-built drawings.

2.5 GROUND BAR

- A. Location: Provide a ground bar in all electrical rooms with step-down transformers and in all communications rooms, or rooms with telephone distribution equipment or network electronics equipment.
- B. Description: Ground bar shall be 24" x 2" x ¼" (minimum) copper bus mounted to wall 24" AFF via insulated standoffs. All connections to ground bar shall be made via approved mechanical connections.
- C. Electrical Room Interconnection: All electrical room ground bars shall be interconnected to each other back to the main service ground via #4/0 insulated grounding conductor. Each ground bar shall also be bonded to local metallic water piping #4/0 insulated grounding conductor.
- D. Telecommunications Room Interconnection: All telecommunications room ground bars shall be interconnected to each other back to the main telecommunications service ground via #4/0 insulated grounding conductor. Each ground bar shall also be bonded to local metallic water piping #4/0 insulated grounding conductor. The main Telecommunications Ground Bar shall be interconnected with the building main electrical service ground via a single #4/0 insulated grounding conductor.
- E. Interconnections: All #4/0 interconnections shall be installed with irreversible lugs. Mechanical lugs are not permitted.

PART 3 - INSTALLATION

3.1 EXTERIOR

A. Connection: The main grounding electrode conductor shall be exothermically welded to ground rods and other main system electrodes.

3.2 INTERIOR

- A. Installation: Equipment grounding conductors shall be installed as follows:
 - 1. Shall be installed in metal conduit, with both conductor and conduit shall be bonded at each end.
 - 2. Have connections accessible for inspection and made with approved solderless connectors brazed (or bolted) to the equipment or structure to be grounded.
 - 3. Shall in NO case be a current carrying conductor.
 - 4. Have green insulation.
- B. Water Meter: Provide properly sized bonding shunt around water meter and/or dielectric unions in the water pipe.
- C. Bushings: Bond all grounding bushings to the equipment ground bus of the panel or switchboard, or overcurrent device in which it is located. Bond shall be made via an insulated bonding conductor of same size as equipment ground conductor run in the circuit.

3.3 TESTING

- A. Testing: Provide testing as required in other sections of this specification, including but not limited to sections 260100 and 260500.
- B. Reports: Submit impedance test reports for all separately derived services to the Engineer prior to project completion.

3.4 CONNECTIONS

A. Preparation: All contact surfaces shall be thoroughly cleaned before connections are made, to ensure good metal to metal contact.

END OF SECTION 26 0526

SECTION 26 0529 RACEWAYS AND CONDUIT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

1.2 DESCRIPTION

- A. General: Provide all supports, hangers and inserts required to mount raceways, pullboxes, and other equipment provided under this Division.
- B. Support: All items shall be supported from the structural portion of the building. Supports and hangers shall be of a type approved by Underwriters' Laboratories. Wire shall not be used as a support. Boxes and raceways shall not be supported or fastened to ceiling suspension wires or to ceiling channels. Do not install any devices supported by ceiling tiles.
- C. Installation: The Contractor shall lay out and provide his work in advance of the laying of floors or walls, and shall provide all sleeves that may be required for openings through floors, walls, etc. Where plans call for raceway to be run exposed, provide all inserts and clamps for the supporting of conduit.
- D. Systems: Provide raceway system of empty raceways including terminal cabinets, backboards and outlets as described and specified within the Division 27 Telecommunications and low voltage documents.

1.3 QUALITY ASSURANCE

- A. Qualifications: Manufacturers shall be regularly engaged in the manufacture of raceway systems and fittings of types and sizes required, and whose products have been in satisfactory use in similar service for not less than 5 years in the USA.
- B. Aluminum Raceways: Aluminum raceways shall be strictly prohibited except for within MRI applications.
- C. Compliance: Materials shall comply with the latest edition of the following standards as they apply to the different raceway types specified herein;
 - 1. ANSI:
 - a. ANSI C80.1: Rigid Steel Conduit (RSC)
 - b. ANSI C80.3: Electrical Metallic Tubing (EMT)
 - 2. UL:
 - a. UL 1: Flexible Metal Conduit
 - b. UL 6: Rigid Steel Conduit (RSC)
 - c. UL 360: Liquid-Tight Flexible Metal Conduit
 - d. UL 514: Fittings for Metal Conduit
 - e. UL 651: Nonmetallic Conduit (PVC)
 - f. UL 797: Electrical Metallic Tubing (EMT)
 - g. UL 886: Fittings for Hazardous Locations

Project No. 121505 Raceways and Conduit Section 26 0529 - 1

- 3. NEMA:
 - a. NEMA TC2: Rigid Nonmetallic Conduit (PVC)
 - b. NEMA TC3: Fittings for Rigid Nonmetallic Conduit (RNMC)
 - c. NEMA RN1: Plastic Coated Metal Conduit
- 4. Federal Specifications:
 - a. WW-C-581: Rigid Steel Conduit (RSC)
 - b. WW-C-563: Electrical Metallic Conduit (EMT)
 - c. WW-C-566: Flexible Steel Conduit
 - d. WC-1094A: Nonmetallic Rigid Conduit (PVC)
 - e. WC-582A Conduit, Raceway, Metal and Fittings; surface

1.4 SUBMITTALS

- A. Products: Submit manufacturer's product data, including technical information on all types of raceway systems;
- B. Compliance: Product data shall show compliance with this section of the specifications, including U.L. label, manufacturer and manufacturer's written installation instructions.

1.5 RACEWAYS

- A. General: Provide a complete and continuous system of raceways to maintain a protected path for wires and cables to distribute electric power, throughout the project, utilizing U.L. listed and labeled materials.
- B. Accessories: Provide raceway accessories of types, sizes, and materials, as specified herein complying with manufacturers published product information, which match and mate conduit and tubing.
- C. Interior Minimum Size: Minimum conduit size for light and power systems shall be 3/4 inch raceway for all power and lighting circuitry homeruns from panelboard to outlet box at first power consuming devices. The remainder of circuitry may be in 1/2 inch raceway, if it contains no more than 4 conductors per raceway (excluding the equipment grounding conductor), and phase conductors no larger than #12 AWG. Switchlegs may be ½ inch conduit unless otherwise noted on drawings.
- D. Site Underground Raceway: Unless otherwise noted, minimum underground raceways shall be 1 inch conduit. Homeruns from the branch circuit overcurrent device, through any control devices to the first exterior junction box or consumption device shall be 1 inch minimum.
- E. System Raceway: Provide end bushings on all conduits.
- F. Pull Strings: Provide pull strings in all empty raceways. Pull strings shall be nylon and shall be impervious to moisture. Pull strings installed in one inch and smaller conduits shall have a tensile strength of not less than 30 lbs. Pull strings installed in conduits larger than 1 inch shall a tensile strength not less than 200 lbs.
- G. Conduit Bends: The use of NEC Table 344.24 Exception is not allowed.

1.6 LOCATIONS

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 **T**

- A. Materials Above Grade: The following conduit types are to be installed above grade where specifically noted herein;
 - 1. Electrical metallic tubing (thin wall)
 - 2. Flexible metal conduit
 - 3. Liquid-tight flexible metal conduit
 - 4. Heavy wall Schedule 40 PVC (lightning protection down conductors only).
 - 5. Galvanized rigid steel conduit
- B. Materials Below Grade: The following conduit types are to be installed below grade where specifically noted herein;
 - 1. Rigid galvanized conduit (heavy wall)
 - 2. Schedule 40 PVC Normal Power, Concrete Encased Emergency Power
 - 3. Schedule 80 PVC Emergency Power
- C. Materials on Roofs: The following conduit types are to be installed on roofs where specifically noted herein;
 - 1. Rigid steel conduit (PVC) coated
 - 2. Liquid tight flexible metal conduit

1.7 MEDICAL PROJECTS SPECIAL CONDITIONS

A. Interior Building Areas: Nonmetallic raceways are not permitted for feeders or branch circuits serving any patient care area (primarily levels 1 and above), either above grade, underground, or in a concrete slab.

1.8 SURFACE RACEWAY

A. General: Provide surface mounted raceway where specifically indicated on the drawings. Raceway shall be metallic and one-piece type. Where wiring channels are specifically specified, they shall be two-piece type.

PART 2 - PRODUCTS

2.1 ELECTRICAL METALLIC TUBING

- A. Fittings: Provide steel set screw fittings. Steel fittings shall be fitted with non-removable insulated throats, and male threaded ends provided with a locknut.
- B. Locknuts: Provide locknuts for securing conduit to enclosures with sharp edges for digging into metal, and ridged outside circumference for proper fastening.

2.2 BUSHINGS

- A. Bushings: Bushings shall be provided on all terminations, all system conduits, mounted on the ends of all EMT connectors 1-1/4 inches and larger and within all equipment.
- B. Construction: Bushings shall have a flared bottom and ribbed sides, with smooth insides to prevent damage to cable insulation.
- C. Insulating Ring: Mold a phenolic insulating ring into sizes 1-1/4 inches and larger.
- D. Grounding: Provide a screw type grounding terminal on all sizes.

E. Grounding Bushings: Grounding bushings shall be provided on all electrical system feeder conduits.

2.3 RIGID METAL CONDUIT

- A. Conduit: Conduit ends shall have precision cut hi-torque threads. One end of the conduit shall have a coupling and the other shall be covered with a color-coded plastic thread protector. Conduit shall be manufactured in 10 foot lengths.
- B. Fittings: Fittings shall be cut groove steel. Cast fittings are not acceptable.

2.4 FLEXIBLE STEEL CONDUIT

- A. Conduit and Standards: A continuous length, spirally wound steel strip, zinc-coated, each convolution interlocked with following convolution into a helix form. Product shall meet Federal Specification WW-C-566 and UL 1242.
- B. Fittings: Provide conduit fittings for use with flexible steel conduit of the threadless hinged clamp type, and a male threaded end provided with a locknut.
 - 1. Straight terminal connectors shall be one piece body, female end with clamp and deep slotted machine screw for securing conduit.
 - 2. 45 and 90 degree terminal angle connectors shall be 2 piece body, with removable upper section, female end with clamp and deep slotted machine screw for securing conduit.

2.5 LIQUID-TIGHT FLEXIBLE STEEL CONDUIT

- A. Conduit: Plastic jacketed (PVC) liquid-tight flexible steel conduit with copper bonding conductor, and steel material galvanized inside and outside.
- B. Fittings: Provide cadmium plated, malleable iron fittings with compression type steel ferrule and neoprene gasket sealing rings with insulated throat.

2.6 HEAVY WALL PVC CONDUIT (SCHEDULE 40)

A. Conduit: Schedule 40, 90 degrees C. UL rated, PVC conduit shall be composed of High Impact PVC (polyvinyl chloride C-2000 Compound), and shall conform to industry standards, and be UL listed in accordance with Article 347 of National Electrical Code for underground and exposed use. Materials must have tensile strength of 55 PSI, at 70 degrees F., flexural strength of 11,000 psi, compression strength of 8600 psi. Manufacturer shall have five years extruding PVC experience.

2.7 EXTRA HEAVY WALL PVC CONDUIT (SCHEDULE 80)

A. Conduit: Schedule 80, 90 degrees C. UL rated, PVC conduit shall be composed of High Impact PVC (polyvinyl chloride C-2000 Compound), and shall conform to industry standards, and be UL listed in accordance with Article 347 of National Electrical Code for underground and exposed use. Materials must have tensile strength of 5500 PSI, at 73.4 degree F., flexural strength of 12,500 psi, compression strength of 9000 psi. Manufacturer shall have five years extruding PVC experience.

2.8 MALLEABLE IRON EXPANSION FITTINGS

- A. Type: Conduit expansion fittings shall be malleable iron (hot dipped galvanized inside and outside).
- B. Fittings: These fittings shall have a 4 inch expansion chamber to allow approximately 2 inch movement parallel to conduit run in either direction from normal.
- C. Internal Bonding: Fittings shall have factory-installed packing and internal tinned copper braid packing to serve as a bonding jumper.
- D. External Bonding: Unless the fitting used is listed by Underwriters Laboratories for use "without external bonding jumpers", an external copper bonding jumper shall be installed with each metal expansion fitting. One end of the fitting shall be clamped on each conduit entering fitting.

2.9 SUPPORTING DEVICES

- A. Hangers: Hangers shall be made of durable materials suitable for the application involved. Where excessive corrosive conditions are encountered, hanger assemblies shall be protected after fabrication by galvanizing, or approved suitable preservative methods.
- B. Materials: Insert anchors shall be installed on concrete or brick construction, with hex head machine screws. Recessed head screws shall be used in wood construction. An electric or hand drill shall be used for drilling holes for all inserts in concrete or similar construction. Installed inserts, brick, shall be near center of brick, not near edge or in joint. Drilled and tapped, and round head machine screws shall be used where steel members occur. All screws, bolts, washers, etc., used for supporting raceways or outlets shall be fabricated from rust-resisting metal, or accepted substitution. Gunpowder set anchors are not permitted.
- C. Exterior: Supporting devices for exterior use shall be 316 stainless steel unless otherwise noted on drawings.
- D. PVC Coated Conduit: Supporting devices for PVC coated conduit shall be as manufactured by the PVC coated conduit manufacturer and shall match in color and appearance.

2.10 WIREWAYS

A. General: Wireway shall be sized as shown on drawings, NEMA 1, lay-in type. Wireway sides and bottom shall contain no knock-outs. The Contractor shall punch holes required. The cover shall be hinge type with quarter turn fasteners to hold cover shut. Covers and bodies shall be 16 gauge steel. Wireway shall be as manufactured by Hoffman Engineering Company, Square "D" or Steel City.

PART 3 - EXECUTION

3.1 CONDUITS

- A. Unless noted otherwise, provide as a minimum 3/4 inch raceway from each of the following device locations to cable tray, j-hooks, or corridor ceiling cavity when cable tray, or j-hooks are not available. Provide insulated bushings at ends of all raceways.
 - 1. DDC/Building Automation Devices
 - 2. Refer to telecommunication/low voltage drawings for additional device locations.

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 121505 Raceways and Conduit Section 26 0529 - 5

TLC Engineering Solutions

- B. All fire alarm wiring shall be run in conduit, and shall be fully color-coded RED. Fire alarm systems located within shell spaces shall be installed without conduit except for stub-up locations for each device.
- C. All wiring above non-accessible ceilings or in open ceiling areas such as mechanical and electrical spaces shall be installed in raceways.

3.2 IDENTIFICATION OF BOXES

A. Tags: During installation of pull strings all pull strings shall be marked with vinyl tags indicating where the opposite end may be found.

3.3 BLANK PLATES

A. Plates: Unless otherwise noted all outlet boxes shall receive blank plates matching the finish of plates on electrical devices in the same room.

3.4 RACEWAY INSTALLATION

- A. Support: All raceways shall be run in a neat and workmanlike manner and shall be properly supported and in accordance with the latest edition of the NEC. Supporting conduit and boxes with wire is not acceptable. Exposed raceways where allowed, shall be supported with clamp fasteners with toggle bolt on hollow walls, and with lead expansion shields on masonry. All conduits shall be securely fastened in place with at least one support per eight foot section. Support within one foot of changes in direction. All required hangers, supports and fastenings shall be provided at each elbow and at no more than one foot from the end of each straight run terminating at a box or cabinet. The use of perforated iron for supporting conduits shall not be permitted. The required strength of the supporting equipment and size and type of anchors shall be based on the combined weight of conduit, hanger and cables. Horizontal and vertical conduit runs may be supported by one-hole malleable straps, clamp-backs, or other accepted devices with suitable bolts, expansion shields (where needed) or beam-clamps for mounting to building structure or special brackets.
- B. Hanger Installation: Where 2 or more raceways 1 inch or larger run parallel trapeze hangers may be used consisting of concrete inserts, threaded solid rods, washers, nuts and galvanized "L" angle iron, or Unistrut cross members. These raceways shall be individually fastened to the cross member of every other trapeze hanger with galvanized cast one hole straps, clamp backs, bolted with proper size cadmium machine bolts, washers and nuts. If adjustable trapeze hangers are used to support groups of parallel conduits, U-bolt type clamps shall be used at the end of a raceway run and at each elbow. J-bolts, or approved clamps, shall be installed on each third intermediate trapeze hanger to fasten each raceway.
- C. Sealant: Provide a closed cell silicone foam sealant rated to provide a rating equal to the wall, ceiling, or floor assembly rating. Provide seals for the exterior of conduit penetrations consisting of a cast-in-place sleeve with a compressible rubber gasket between the conduit and the sleeve. Provide seals for the interior of the conduit penetrations consisting of gland type sealing bushing or closed cell silicone foam. Provide duct seal inside an appropriate seal-off fitting to seal the interior of the conduit system from water seepage or hazardous gases.
- D. Routing: Raceways shall be run parallel to building walls wherever possible, exposed or concealed as specified, and shall be grouped in a workmanlike fashion. Crisscrossing of conduits shall be minimized.

- E. Location: All raceways except those from surface-mounted switches, outlet boxes or panels shall be run concealed from view. Surface mounted devices and equipment shall be specifically noted on the contract drawings. It is the intent that all raceways shall be run concealed unless specifically noted.
- F. Protection: All raceway runs, whether terminated in boxes or not, shall be capped during the course of construction until wires are pulled in and covers are in place. No conductors shall be pulled into raceways until the raceway system is complete.
- G. Coordination: All raceways shall be kept clear of mechanical equipment and plumbing fixtures to facilitate future repair or replacement of said fixtures without disturbing wiring. Except where it is necessary for control purposes, all raceways shall be kept away from items producing heat.
- H. Masonry Installation: All raceway runs in masonry shall be installed at the same time as the masonry so that no face cutting is required, except to accommodate boxes.
- I. Arrangement: All raceways shall be run connecting outlet to circuits generally as shown on the drawings. Provide circuit connection arrangement shown. Actual final arrangement shall be in accordance with the record drawings section as specified herein.
- J. Grounding: All branch circuit and feeder raceways shall have a copper system ground conductor within the conduit throughout the entire length of the circuit. All conduit shall be electrically continuous to establish redundant grounding.
 - 1. Branch circuit raceways shall have an insulated equipment grounding conductor installed within the conduit raceway system.
 - 2. Grounding conductor shall be included in total conduit fill determining conduit sizes, even though not shown on drawings.
 - 3. Grounding conductors run with feeders shall be insulated.
 - 4. Grounding conductors run with normal and essential electrical system feeders serving patient care area shall be bonded to portions of raceway that are metal by listed grounding bushings.
- K. Empty Raceways: Raceways which do not have conductors provided under this Division of the specifications shall be left with an acceptable nylon pullcord in raceway.
- L. Manufacturer: Rigid Metallic Conduit, Electrical Metallic Tubing, Flexible Steel Conduit, Liquid-Tight Flexible Conduit, and PVC Conduit shall be manufactured within the United States, and each shall be as manufactured by one manufacturer.
- M. Roof Installation: Raceway installations on roofs shall be kept to a bare minimum. Raceway shall be supported above roof at least 6 inches using approved raceway supporting devices. Supports shall be fastened to roof using roofing adhesive as specified in other sections of this specification.
- N. Firewall Installation: Provide pullboxes, junction boxes, fire barrier at fire rated walls etc., as required by NEC Article 300 where required.
- O. Dissimilar Metals: Avoid the use of dissimilar metals to reduce the possibility of electrolysis. Where dissimilar metals are in contact, coat all surfaces with corrosion inhibiting compound before assembling.
- P. Sealoff Fittings: Provide raceway sealoffs wherever the raceway system enters a hazardous or wet area or areas of drastic temperature change such as coolers, freezers, etc. as required.

- Q. Identification: Provide appropriate identification as required by codes and as indicated on the drawings and in accordance with the methods specified herein.
- R. Anchors: Raceways shall be anchored down to prevent floating while pouring in concrete.

3.5 SITE UNDERGROUND CONDUIT INSTALLATION

- A. General: All underground raceways (with exception of raceways installed under floor slab) shall be installed in accordance with Section 300-5 of the NEC except that the minimum cover for any raceway or duct bank shall be two feet, unless otherwise indicated.
- B. Stubs: Spare raceway stubs shall be capped and accurately dimensioned on as-built drawings.
- C. Separation: All raceways run underground, or stubbed above floor shall be separated with plastic interlocking spacers manufactured specifically for this purpose, or shall be strapped to Kindorf channel supported by raceway driven into ground or tied to steel.
- D. Coating: Rigid metallic conduit installed underground shall be coated with waterproofing black mastic before installation, and all joints shall be recoated after installation.

3.6 RIGID METALLIC CONDUIT

- A. Locknuts: Rigid steel box connections shall be made with double locknuts and bushings. Turn down on threads to solidly connect raceway to box or enclosure.
- B. Bushings: Grounded insulated bushings shall be used on all rigid steel conduits terminating in panels, wire gutters, or cabinets in accordance with NEC 517. Bushing shall be impact resistant plastic molded in an irregular shape at the top to provide smooth insulating surface at top and inner edge. Material in these bushings must not melt or support flame.

3.7 PVC RACEWAYS

- A. Restricted Location: PVC raceways shall not be used in any patient care areas or for any essential electrical system feeders unless specifically noted. PVC shall be used for lightning protection down conductors and grounding electrode raceways.
- B. Floor Penetrations Exposed: Where PVC penetrates a floor in an exposed location from underground or in slab, a black mastic coated steel conduit elbow shall be used.
- C. Location: No PVC shall be allowed anywhere except underground or in slab, with the exception that PVC conduit may be used in non-fire rated poured block walls and poured in place columns. Refer to other sections of this specification for other restrictions.
- D. Ground Conductor Installation: All individual bare copper ground conductors (i.e. service or lightning protection grounds) shall be installed in PVC raceway.
- E. Joints: PVC joints shall be solvent welded. Threads shall not be permitted on PVC raceway and fittings, except for rigid steel to PVC couplings. Installation of PVC raceway shall be in accordance with manufacturer's recommendations.
- F. Restrict Support: PVC raceway shall not be used to support fixture or equipment.

G. Bends: Field bends shall be made with an approved hotbox. Heating with flame and hand held dryers are prohibited.

3.8 FLEXIBLE CONNECTIONS

- A. Vibrating Equipment Connection: All connections to motors or other vibrating equipment (except dry type transformers) or at other locations where required shall be made with not less than 12 inches of flexible liquid-tight steel conduit, using special type of connectors with strain relief fittings at both terminations of conduit, Kellems Type 074-09 Series or accepted substitution.
- B. Normal Type: Flex connectors shall have insulated throat and shall be T & B 3100 Series or accepted substitution.
- C. Angle Type: Use angle connectors wherever necessary to relieve angle strain on flex conduit.
- D. Transformer Connection: Connections to dry type transformers shall be made with flexible conduit.

3.9 EXPANSION FITTINGS

- A. Installation: Provide expansion fittings in each conduit run wherever it crosses an expansion joint. Install the fitting on one side of the joint with its sliding sleeve end flush with joint, and with a length of bonding jumper in expansion equal to at least three times the normal width of joints.
- B. Location: Provide expansion fittings in each conduit run which is mechanically attached to separate structures to relieve strain caused by shift on one structure in relation to the other.
- C. Length: Provide expansion fittings in straight raceway runs above ground which are more than one hundred feet long.

3.10 ELECTRICAL METALLIC TUBING

- A. Location: Install Electrical Metallic Tubing (thin wall) inside buildings, above the ground floor where not subject to mechanical injury.
- B. Handling: All cut ends shall be reamed to remove rough edges.

END OF DOCUMENT 26 0529

SECTION 26 0533 OUTLET BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work specified of this section.

1.2 **DESCRIPTION**

- A. General: Outlet boxes shall be of such form and dimensions as to be adapted to the specific use and location, type of device or fixtures to be used, and number and size of conductors and arrangement, size and number of conduits connecting thereto.
- B. Ceiling Size: Ceiling outlet boxes shall be 4 inch octagonal or 4 inch square by 1-1/2 inches deep or larger as required for number and size of conductors and arrangement, size and number of conduits terminating at them.
- C. Wall Size: Switch, wall receptacle, telephone and other wall outlet boxes in drywall shall be 4 inch square by 1-1/2 inches deep. For exposed masonry, provide one piece 4 inch square by 1-1/2 inches deep wall boxes with appropriate 4 inches square cut tile wall covers Steel City series #52-C-49/52-C-52 or accepted substitution. For furred-out block walls, provide 4 inch square box with required extension for block depth and required extension for drywall depth.

1.3 QUALITY ASSURANCE

- A. Qualifications: Manufacturers shall be regularly engaged in the manufacture of conduit systems and fittings of types and sizes required, and whose products have been in satisfactory use in similar service for not less than 5 years in the USA.
- B. Compliance: Materials shall comply with the following standards as they apply to the different raceway types specified herein.
 - 1. UL-50 & UL-514
 - 2. NFPA 70 National Electrical Code

1.4 FLOOR OUTLETS

A. General: Provide floor outlet boxes as shown on the plans. Installation shall be in accordance with the National Electrical Code, and shall be complete with service fittings as indicated. Equipment shall be listed by Underwriters' Laboratories, Inc.

1.5 SPECIAL PURPOSE OUTLETS

A. Location: Locate special purpose outlets as indicated on the drawings for the equipment served. Location and type of outlets shall be coordinated with appropriate trades involved. The securing of complete information for proper electrical roughing-in shall be included as work required under this section of specifications.

1.6 SUBMITTALS

Project No. 121505 Outlet Boxes Section 26 0533 - 1
A. Submittals: Submit product data on all different types of outlet boxes and associated trim/plaster rings.

PART 2 - PRODUCTS

2.1 GENERAL PURPOSE BOXES

A. General: Provide standard galvanized one-piece steel outlet boxes at all concealed outlets for electric lights, switches, convenience receptacles, telephone outlets, etc.
 Acceptable manufacturers shall be T&B, Steel City, Raco. Surface outlet boxes and conduit bodies shall be the heavy cast aluminum or iron with external raised hubs - Appleton, Crouse Hinds or Steel City or accepted substitution. Trim rings shall also be of one piece construction.

2.2 FLOOR OUTLET BOXES

- A. Standards: Outlets in slab on grade shall conform to Federal Specifications No. WC-526b, Type 1, with threaded conduit hubs.
- B. Carpet Locations: In carpeted areas, Lexan carpet flanges shall be installed to protect carpet edges where flush floor boxes are installed.
- C. Construction: All assemblies shall be designed and installed to maintain grounding continuity, fireproofing and watertight integrity. Connections to boxes in slabs on grade shall be made tight or sealed to prevent entrance of moisture.
- D. Accessories: Box trim, service fittings and accessories shall be as required to provide a complete installation.
- E. Special Consideration: Flush caps removed to provide service fittings shall be turned over to the Owner. Approved manufacturer is Walkerduct.
- F. Low Voltage Compartment: Coordinate box selection with Division 27 requirements where required.
- G. Manufacturer: Approved manufacturer is Walker, Raco, Steel City or Hubbell. Coordinate final device selection with requirements identified in the low voltage/technology documents.

PART 3 - EXECUTION

3.1 INSTALLATION OF OUTLET BOXES

A. Installation: All flush outlets shall be mounted so that covers and plates shall finish flush with finished surfaces without the use of shims, mats or other devices not submitted or accepted for the purpose. Add-a-Depth ring or switch box extension rings (Steel City #SBEX) are not acceptable. Plates shall not support wiring devices. Gang switches with common plate where two or more are indicated in the same location. Wall-mounted devices of different systems (switches, thermostats, etc.) shall be coordinated for symmetry when located near each other on the same wall. Outlets on each side of walls shall have separate boxes. Through-wall type boxes shall not be permitted. Back-to-back mounting shall not be permitted. Trim rings shall be extended to within 1/8 inch of finish wall surface.

- B. Stud Walls: Outlet boxes mounted in metal stud walls, shall be supported to studs with 2 screws inside of outlet box to a horizontal stud brace between vertical studs.
- C. Blank Covers: All outlet boxes that do not receive devices in this contract are to have blank plates installed matching wiring device plates.

3.2 MOUNTING HEIGHT

A. Mounting Height: Height of wall outlets to center or bottom of box above finished floor shall be as follows, unless specifically noted otherwise. Verify all heights with the architectural plans and shop drawings for installation. The following dimensions are a guide only. Specific heights required by governing institutions and laws shall apply.

Switches & Dimmers	4 foot 0 inches to centerline
Receptacles	1 foot 6 inches to centerline
Branch Panelboards	6 foot 6 inches top of panel trim
Telephone & Data Outlets	1 foot 6 inches to centerline

- B. Counter Tops: Bottoms of outlets above counter tops or base cabinets shall be minimum 2 inches above counter top or backsplash, whichever is highest. Outlets may be raised so that bottom rests on top of concrete block course, but all outlets above counters in same area shall be at same height. It is the responsibility of this Contractor to secure cabinet drawings and coordinate outlet locations in relation to all cabinets as shown on Architectural plans, prior to rough-in, regardless of height shown on documents.
- C. Wall Outlets: Height of wall-mounted fixtures shall be as shown on the drawings or as required by Architectural plans and conditions. Fixture outlet boxes shall be equipped with fixture studs when supporting fixtures.

3.3 FLOOR OUTLET BOXES

A. Adjustment: Where floor or fill depth is 3 inches or more, adjustable boxes with maximum vertical and angular adjustment for after concrete pour shall be used. After pour is complete, boxes shall be set and readjusted to provide a smooth surface conforming to the elevation and slope of the surrounding finished floor.

END OF DOCUMENT 26 0533

SECTION 26 0548 VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Elastomeric isolation pads.
 - 2. Restraints rigid type.
 - 3. Restraints cable type.
 - 4. Restraint accessories.
 - 5. Post-Installed concrete anchors.
 - 6. Concrete inserts.
- B. Related Requirements:
 - 1. Section 26 0529 "Hangers and Supports for Electrical Systems" for commonly used electrical supports and installation requirements.
- C. This project is located in Seismic Category D. All seismic bracing shall meet or exceed those requirements for bracing at this category level.

1.2 **DEFINITIONS**

A. OSHPD: Office of Statewide Health Planning and Development (for the State of California owned and regulated medical facilities).

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated load capacity for each seismic restraint device.
 - 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic restraint component used.
 - 3. Annotate types and sizes of seismic restraints and accessories, complete with listing markings or report numbers and load rating in tension and compression as evaluated by an agency acceptable to authorities having jurisdiction.
 - 4. Annotate to indicate application of each product submitted and compliance with requirements.
- B. Shop Drawings:
 - 1. Detail fabrication and assembly of equipment bases.
 - 2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
- C. Delegated Design Submittal for Each Seismic-Restraint Device: Signed and sealed by qualified structural professional engineer.

- 1. For each seismic-restraint device, including restraint rigid and cable type, restraint accessory, and concrete anchor and insert that is required by this Section or is indicated on Drawings, submit the following:
 - a. Seismic Restraints: Select seismic restraints complying with performance requirements, design criteria, and analysis data.
 - b. Post-Installed Concrete Anchors and Inserts: Include calculations showing anticipated seismic loads. Include certification that device is approved by an NRTL for seismic reinforcement use.
 - c. Seismic Design Calculations: Submit input data and loading calculations prepared under "Seismic Design Calculations" Paragraph in "Performance Requirements" Article.
- D. Delegated Design Submittal for Each Wind-Load Protection Device: Signed and sealed by qualified structural professional engineer.
 - 1. For each wind-load protection device, including restraint rigid and cable type, restraint accessory, and concrete anchor and insert that is required by this Section or is indicated on Drawings, submit the following:
 - a. Wind-Load Restraint: Select wind-load restraints complying with performance requirements, design criteria, and analysis data.
 - b. Post-Installed Concrete Anchors and Inserts: Include calculations showing anticipated wind loads. Include certification that device is approved by an NRTL for reinforcement use.
 - c. Wind-Load Design Calculations: Submit static and dynamic loading calculations prepared under "Wind-Load Design Calculations" Paragraph in "Performance Requirements" Article.
 - 2. Seismic Restraint Detail Drawings: Signed and sealed by qualified structural professional engineer.
 - a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
 - c. Coordinate seismic-restraint details with wind-load details required for equipment mounted outdoors.
 - 3. Product Listing, Preapproval, and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage qualified structural professional engineer to design seismic control system.
- B. Seismic Restraint Device Load Ratings: Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by an agency acceptable to authorities having jurisdiction.
- C. Consequential Damage: Provide additional restraints for suspended components or anchorage of floor-, roof-, or wall-mounted components so that failure of a non-essential or essential component will not cause failure of any other essential building component.
- D. Fire/Smoke Resistance: Seismic restraint devices that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL in accordance with ASTM E84 or UL 723, and be so labeled.
- E. Component Supports:
 - 1. Load ratings, features, and applications of reinforcement components must be based on testing standards of a nationally recognized testing agency.

2.2 ELASTOMERIC ISOLATION PADS

- A. Elastomeric Isolation Pads:
 - 1. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
 - 2. Size: Factory or field cut to match requirements of supported equipment.
 - 3. Pad Material: Oil and water resistant with elastomeric properties. Neoprene rubber, silicone rubber, or other elastomeric material.
 - 4. Surface Pattern: Smooth, ribbed, or waffle pattern.
 - 5. Infused nonwoven cotton or synthetic fibers.
 - 6. Load-bearing metal plates adhered to pads.
 - 7. Sandwich-Core Material: Resilient and elastomeric.
 - a. Surface Pattern: Smooth, ribbed, or waffle pattern.
 - b. Infused nonwoven cotton or synthetic fibers.

2.3 RESTRAINTS - RIGID TYPE

A. Description: Shop- or field-fabricated bracing assembly made of ANSI/AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.4 **RESTRAINTS - CABLE TYPE**

- A. Seismic Restraint Cables: ASTM A1023/A1023M galvanized or ASTM A603 galvanized-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for seismic-restraining cable service; with fittings attached by means of poured socket, swaged socket, or mechanical (Flemish eye) loop.
- B. Restraint cable assembly and cable fittings must comply with ASCE/SEI 19. Cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

2.5 **RESTRAINT ACCESSORIES**

- A. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod. Non-metallic stiffeners are unacceptable.
- B. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.
- C. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- D. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
- E. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.6 POST-INSTALLED CONCRETE ANCHORS

- A. Mechanical Anchor Bolts:
 - 1. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength for anchor and as tested according to ASTM E488/E488M.
- B. Adhesive Anchor Bolts:
 - 1. Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.
- C. Provide post-installed concrete anchors that have been prequalified for use in seismic and windload applications.
 - 1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
 - 2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.

- D. Expansion-type anchor bolts are not permitted for equipment in excess of 10 hp (7.46 kW) that is not vibration isolated.
 - 1. Undercut expansion anchors are permitted.

2.7 CONCRETE INSERTS

- A. Provide preset concrete inserts that are seismically prequalified in accordance with ICC-ES AC446 testing.
- B. Comply with MSS SP-58.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive seismic control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- B. Hanger-Rod Stiffeners: Install where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods caused by seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry static and seismic loads within specified loading limits.

3.3 INSTALLATION OF SEISMIC-RESTRAINT DEVICES

- A. Provide seismic restraint devices for systems and equipment where indicated in Equipment Schedules or Seismic and Wind-Load Controls Schedule, where indicated on Drawings, where the Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.
 - 1. Install equipment and devices to withstand the effects of earthquake motions.
- B. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 03 3000 "Cast-in-Place Concrete."
- C. Installation of seismic restraints must not cause any stresses, misalignment, or change of position of equipment or conduits.
- D. Equipment Restraints:

- 1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
- 2. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- E. Raceway, Cable, Wireway, Cable Tray, and Busway Support and Hanger Restraints:
 - 1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
 - 2. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
 - 3. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
 - 4. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- F. Install cables so they do not bend across edges of adjacent equipment or building structure.
- G. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- H. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- I. Post-Installed Concrete Anchors:
 - Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 3. Mechanical-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors must be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - 4. Adhesive-Type Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 - 5. Set anchors to manufacturer's recommended torque using a torque wrench.
 - 6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where connection is terminated to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.5 FIELD QUALITY CONTROL

A. Field tests must be witnessed by Architect, authorities having jurisdiction, or other agency approved to review such tests.

- B. Tests and Inspections:
 - 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 - 2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
 - 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 - 4. Test no fewer than four of each type and size of installed anchors and fasteners selected by Architect.
 - 5. Test to 90 percent of rated proof load of device.
- C. Nonconforming Work:
 - 1. Seismic controls will be considered defective if they do not pass tests and inspections.
 - 2. Remove and replace malfunctioning units and retest as specified above.
- D. Prepare test and inspection reports.

END OF SECTION 26 0548

SECTION 26 0553 ELECTRICAL IDENTIFICATION

PART1- GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work specified of this section.

1.2 DESCRIPTION

- A. Extent: Electrical identification work as required by the Contract Documents or other specifications.
- B. Types: Electrical identification work specified in the Contract Documents include the following;
 - 1. Electrical power, control and communication conductors.
 - 2. Operational instructions and warnings.
 - 3. Danger signs.
 - 4. Conduits, boxes, etc.
 - 5. Distribution Equipment.
 - 6. Cabinets.
 - 7. Equipment/system identification signs and tags.

1.3 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacturer of electrical identification products of types required, whose products have been in satisfactory use in similar service for not less than 3 years.
- B. NEC Compliance: Comply with NEC as applicable to installation of identifying labels and markers for wiring and equipment.
- C. UL Compliance: Comply with applicable requirements of UL Standard 969, "Marking and Labeling Systems", pertaining to electrical identification systems.
- D. ANSI Compliance: Comply with applicable requirements of ANSI Standard A13.1, "Scheme for the Identification of Piping Systems", and ANSI Standard Z53.1 "Color Designation."
- E. NEMA Compliance: Comply with applicable requirements of NEMA Standard No's. WC-1 and WC-2 pertaining to identification of power and control conductors.
- F. ADA Compliance: All signage shall meet ADA standards. Identification for maintenance purposes shall be as specified herein.

1.4 SUBMITTALS

A. General: Submit shop drawings of all identification materials to be used for this project. Submit one sample of each item with the shop drawings.

PART 2 - PRODUCTS

2.1 ACCEPTABLE SUPPLIERS OR MANUFACTURERS

- A. General: Subject to compliance with requirements, manufacturers offering electrical identification products which may be incorporated in the work include, but not limited to, the following:
 - 1. Alarm Supply Co, Inc.
 - 2. Direct Safety Co.
 - 3. Ideal Industries, Inc.
 - 4. LEM Products, Inc.
 - 5. Markal Company
 - 6. National Band and Tag Co.
 - 7. Panduit Corp.
 - 8. Seton Name Plate Co.
 - 9. Thomas and Betts Co.
 - 10. Carlton Industries, Inc.

2.2 LANGUAGE

A. General: Provide all products in this section in English.

2.3 ELECTRICAL IDENTIFICATION MATERIALS

- A. General: Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than one single type is specified for an application, selection shall be at the installer's option, however, provide a single selection for each application.
- B. Voltage Marking: Except as otherwise indicated, provide lettering which indicates voltage of the conductor(s) in conduit. Provide 4 inch minimum length with 7/8 inch minimum lettering for 2 inch and smaller conduit. Provide 8 inch minimum length with 1-1/4 inch minimum lettering for larger than 2 inch conduit. Provide one marker for each 20' section of conduit. Color shall match system printing requirements.
- C. Painted Band: Provide painted bands in color to match plastic markers or tape on all conduit. Provide colors as specified herein.
- D. Cable/Conductor Identification Bands: Provide manufacturer's standard vinyl cloth selfadhesive cable/conductor markers of the wrap-around type; either pre-numbered plastic coated type, or write-on type with clear plastic self-adhesive cover flap; numbered to show circuit identification.
- E. Plasticized Tags: Manufacturer's standard preprinted or partially preprinted accident prevention and operation tags, of plasticized card stock with matt finish suitable for writing, approximately 3-1/4 x 5-5/8 inch, with brass grommets and wire fasteners, and with appropriate pre-printed wording including large size primary wording, e.g., DANGER, CAUTION, DO NOT OPERATE.
- F. Baked Enamel Danger Signs: Provide manufacturer's standard "DANGER" signs of baked enamel finish on 20 gauge steel; of standard red, black and white graphics; 14 x

10 inch size except where 10 x 7 inch is the largest size which can be applied where needed, and except where larger size is needed for adequate vision; with recognized standard explanation wording, and subsequent directive e.g. HIGH VOLTAGE, KEEP OUT; BURIED CABLE, DO NOT DIG; LIVE PARTS, DO NOT TOUCH SWITCH.

- G. Engraved Plastic Laminate Nameplates: Provide engraving phenolic plastic laminate, minimum 1/16 inch thick, engraved with square standard pica lettering and wording as specified herein. Provide beveled edge in order to eliminate sharp corners. Provide contact type permanent adhesive for adhering nameplate to the substrate. Adhesive nameplate shall be permanently installed. Titles shall be 1/2 inch high and all other lettering shall be 1/4 inch high.
 - 1. Use following colors for nameplate coloring:

	System	Color
(1)	Life Safety	Bright Yellow with Black Letters
(2)	Critical Branch	Bright Orange with White Letters
(3)	Critical UPS Branch	Bright Blue with White Letters
(4)	Equipment Branch	Kelly Green with White Letters
(5)	Essential Distribution	Purple with White Letters
(6)	Normal Power	Black with White Letters
(7)	Fire Alarm	Red with White Letters

- H. Underground Type Plastic Line Marker: Manufacturer's standard permanent, bright colored, continuous printed, metal backed plastic tape, intended for direct burial service; not less than 6 inches wide x 4 mils thick. Provide tape with printing which most accurately indicates the type of service or type of buried cable.
- I. Junction Box Identification: Provide neat indelible felt tip, stenciled marking on junction box and pullbox covers indicating panel and circuit numbers contained in the box. Letter sizes shall be 1 inch high minimum. Provide non-stenciled markings inside the junction box and on the exterior edge to match the cover markings.

2.4 LETTERING AND GRAPHICS

- A. General: Coordinate names, abbreviations, and other designations used in electrical identification work, with corresponding designations specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by the manufacturer and as required for proper identification and operation/maintenance of the electrical system equipment. Comply with ANSI A13.1 pertaining to minimum sizes for letters and numbers.
- B. Size: System identification labeling consists of providing minimum 1/2 inch high <u>stenciled</u> black letters for raceway systems.

PART 3 - EXECUTION

3.1 APPLICATION AND INSTALLATION

- A. Installation: Install electrical identification products as indicated, in accordance with manufacturer's written instructions, as required by the NEC and as specified herein.
 - 1. Sequence: If identification is applied to surfaces that require finish, install identification after completing finish work.

- B. Coordination: Where identification is to be applied to surfaces which require a field finish application, install identification after completion of such application.
- C. Regulations: Comply with governing regulations and requests of governing authorities for the identification of electrical work.
- D. Hazards: Identify all rooms, spaces, and equipment that house potential electrical hazards, and label with appropriate signage or indicators.

3.2 RACEWAY SYSTEM IDENTIFICATION

- A. Color Coding: All electrical conduit shall be identified by color-coding. Apply color-coded identification on electrical conduit in a neat and workmanlike manner. Utilize a stencil for application of paint.
- B. Identification: Identify all raceways provided or utilized as part of this project as follows;
 - 1. Apply bands 10 feet on center along the raceway system and at each side of walls or floors, and at branches from mains.
 - 2. Identify the following services:

	<u>S</u>	ervice	<u>Label</u>
a.	Low	Voltage	120/208 Voltage
b.	 High Voltage 		277/480 Voltage
c.	. Fire Alarm		Fire Alarm
d.	Nurse Call		Nurse Call
e.	Emergency		
	(1)	Life Safety	Life Safety
	(2)	Critical Branch	Critical Branch
	(3)	Critical UPS Branch	Critical UPS Branch
	(4)	Equipment Branch	Equipment Branch

- f. Refer to Telecommunication/Low Voltage System drawings and Specifications for additional requirements.
- 3. Spot Painting on Rough-in:

<u>System</u> Life Safety

Critical Branch Critical UPS Branch

Equipment Branch

Essential Distribution

- a. Conduit, raceways, boxes, backboxes, panelboards, etc. shall be spot painted at 10'-0" intervals. Conduit shall be identified within 6 inches of the box or enclosure. The entire box and coverplate shall be painted.
 - (1) Painting of conduit fittings in lieu of painted "bands" shall not be permitted.
- b. Use following colors for color bands and for color coding:

Color
Bright Yellow
Bright Orange
Bright Blue w/Bright Orange Stripes
Kelly Green
Purple

(1) (2)

(3)

(4)

(5)

TLC Engineering Solutions

Project No. 121505 Electrical Identification Section 26 0553 - 4 (6) Normal Power

No Color Red

- (7) Fire Alarm
- (8) Refer to Telecommunication/Low Voltage System drawings for additional requirements.

3.3 CABLE/CONDUCTOR IDENTIFICATION

- A. General: Apply cable/conductor identification, including voltage, phase and feeder number, on each cable/conductor in each box/enclosure/cabinet where conductors of more than one circuit or communication (such as color coded conductors) is provided. Match identification with marking system used in panelboards, shop drawings, contract documents, and similar previously established identification for the project's electrical work.
- B. Color Coding: Color code all power and lighting cable. Use wire colored by integral pigmentation, making the wire 100 percent colored. Color coding shall be as follows:

VOLTS
Black
Red
Blue
White (with colored stripe to match phase conductor for single phase circuits)
Green
277/480
277/480 <u>VOLTS</u>
277/480 <u>VOLTS</u> Brown
277/480 <u>VOLTS</u> Brown Orange
277/480 <u>VOLTS</u> Brown Orange Yellow
277/480 <u>VOLTS</u> Brown Orange Yellow Gray (with colored stripe to match phase conductor for single phase circuits)

3.4 OPERATIONAL IDENTIFICATION AND WARNINGS

- A. General: Provide identification and warning wherever reasonably required to ensure safe and efficient operation and maintenance of the electrical systems. Provide identification and warning identification if necessary for signage to help prevent misuse of electrical facilities by unauthorized personnel.
- B. Plasticized signs: Install self-adhesive plastic signs or similar equivalent identification, instruction or warnings on switches, outlets and other controls, devices and covers of electrical enclosures. Where detailed instructions or explanations are needed, provide plasticized tags with clearly written messages adequate for the intended purposes.
- C. Locations: In addition to installation of danger signs required by governing regulations and authorities, install appropriate danger signs at locations indicated and at locations subsequently identified as constituting dangers for persons in or about the project.
- D. High Voltage: Install danger signs wherever it is practicable, for persons to come into contact with electrical power of voltages higher than 277 volts to ground.

- E. Critical Switches/Controls: Install danger signs on switches and similar controls, regardless of whether concealed or locked up, where untimely or inadvertent operation (by anyone) could result in significant danger to persons, or damage to or loss of property.
- F. Electrical Equipment Rooms: Provide warning signage at the entrance to each such room; identify the hazard, and direct non-qualified personnel to stay away.
- G. Equipment Identification:
 - 1. Nameplates: Install an engraved phenolic plastic laminate nameplate on each unit of electrical equipment in the building, including central or master unit of each electrical system unless unit is specified with its own self-explanatory identification or signal system. Except as otherwise indicated, provide single line of text. Provide text matching terminology and numbering of the contract documents and shop drawings.
 - 2. Locations: Provide nameplates for each unit of the following categories of electrical work:
 - a. Switchboard, panelboards, electrical cabinets, and enclosures.
 - (1) Provide a nameplate outside above the door (if equipped with one) listing its designation, voltage, source and circuit number.
 - b. Access panel/doors to electrical facilities.
 - c. Major electrical switchgear and switchboards.
 - d. Electrical Substations.
 - e. Power Transfer Equipment.
 - f. Transformers.
 - g. Battery Charging Equipment.
 - h. Rectifiers.
 - i. Motor starters.
 - j. Disconnect switches.
 - k. Enclosed circuit breakers.
 - I. Light switch cover plate -
 - Provide 3/16 inch engraved and "filled in" lettering indicating panelboard and circuit number "where fed from" for all switches.
 Fill emergency power coverplates with red filler. Fill normal power coverplates with black filler.
 - (2) Division 26 Contractor shall be responsible for the engraving of all O.F.C.I. medical headwall and medical articulating arm/boom unit coverplates (receptacles, light switches, etc.). Contractor shall be responsible for obtaining coverplates from Owner's vendor in ample time to adhere to the project schedule.
 - m. Receptacle Coverplate -
 - (1) Provide 3/16 inch engraved and "filled in" lettering indicating panelboard and circuit number "where fed from" for all

receptacles. Fill emergency power coverplates with red filler. Fill normal power coverplates with black filler.

- (2) Division 26 Contractor shall be responsible for the engraving of all O.F.C.I. medical headwall and medical articulating arm/boom unit coverplates (receptacles, light switches, etc.). Contractor shall be responsible for obtaining coverplates from Owner's vendor in ample time to adhere to the project schedule.
- n. Communication Control Panels, Terminal Cabinets and Equipment Cabinets.
- o. Remote Annunciators
- p. Other similar equipment as designated by the Engineer.
- 3. Viewing: Install nameplates at locations indicated and where not otherwise indicated at a location for the best convenience of viewing without interference with operation and maintenance of equipment.
 - a. Secure to substrate with rigid fasteners. Utilize adhesive where fasteners cannot penetrate substrate.
 - b. Designate branch of electrical power system (i.e. Normal, Life Safety, Critical, or Equipment branch) on nameplate along with Equipment designation.
- 4. Names: The names or wording used for a particular machine shall be the same as the one used on all motor starters, disconnects and remote button stations nameplates for that machine.

END OF DOCUMENT 26 0553

SECTION 26 0800 COMMISSIONING OF ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes commissioning process requirements for electrical systems, assemblies, and equipment.

1.3 ALLOWANCES

A. Labor, instrumentation, tools, and equipment costs for technicians for the performance of commissioning testing are covered by the "Schedule of Allowances" Article in Division 01 Section "Allowances."

1.4 UNIT PRICES

A. Commissioning testing allowance may be adjusted up or down by the "List of Unit Prices" Article in Division 01 Section "Unit Prices" when actual man-hours are computed at the end of commissioning testing.

1.5 CONTRACTOR'S RESPONSIBILITIES

- A. Perform commissioning tests at the direction of the CxA.
- B. Attend construction phase controls coordination meeting.
- C. Attend testing, adjusting, and balancing review and coordination meeting.
- D. Participate in Electrical systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.
- E. Provide information requested by the CxA for final commissioning documentation.
- F. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.6 CxA'S RESPONSIBILITIES

- A. Provide Project-specific construction checklists and commissioning process test procedures for actual Electrical systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.
- B. Direct commissioning testing.
- C. Verify contractor testing work is complete.

D. Provide test data, inspection reports, and certificates in Systems Manual.

1.7 COMMISSIONING DOCUMENTATION

- A. Provide the following information to the CxA for inclusion in the commissioning plan:
 - 1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
 - 2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
 - 3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for Electrical systems, assemblies, equipment, and components to be verified and tested.
 - 4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
 - 5. Certificate of readiness certifying that electrical systems, subsystems, equipment, and associated controls are ready for testing.
 - 6. Test and inspection reports and certificates.
 - 7. Corrective action documents.

1.8 SUBMITTALS

- A. Certificates of readiness.
- B. Certificates of completion of installation, prestart, and startup activities.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TESTING PREPARATION

- A. Certify that electrical systems, subsystems, and equipment as part of the systems being commissioned, including electrical systems that interface with HVAC systems being commissioned, have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- C. Inspect and verify the position of each device and interlock identified on checklists.
- D. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- E. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.2 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- B. Scope of electrical testing shall include electrical systems as indicated below, including interface with HVAC systems being commissioned.
 - 1. Refer to section 01 9113 for scope of electrical systems testing and for equipment strategies and sampling requirement functional performance test requirements.
- C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions.
- D. The CxA along with the Electrical Subcontractor shall prepare detailed testing plans, procedures, and checklists for electrical systems, subsystems, and equipment to be commissioned.
- E. Tests will be performed using design conditions whenever possible. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions.
- F. The CxA may direct that set points be altered when simulating conditions is not practical.
- G. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- H. If tests cannot be completed because of a deficiency outside the scope of the electrical system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- I. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.3 ELECTRICAL, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

- A. Generator and Emergency Power and Acceptance Procedures: Testing requirements are specified in Division 26 Standby Generator, Automatic Transfer Switch, and Emergency Power Systems Sections. Provide submittals, test data, factory load test, field load-bank test, and engine-generator certification to the CxA.
- B. Electrical Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of breakers, panels, switchboards, feeders, etc, and other distribution systems as required by the Cx Plan and CxA.
- C. Lighting Controls: Provide technicians, instrumentation, tools, and equipment to test performance of lighting control systems and daylighting control devices/systems.

3.4 NON-CONFORMANCE

A. The CxA will record the results of the Functional Performance Tests. All deficiencies, non-conformance issues, or test failures will be noted and reported to the Contractors in a deficiency list or in a punch-list format.

- B. Corrections of minor deficiencies identified may be made during the tests at the discretion of the CxA. In such cases the deficiency and resolution will be documented on the procedure form.
- C. Every effort will be made to expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the procedures. However, the CxA will not be pressured into overlooking deficient work or loosening acceptance criteria to satisfy scheduling or cost issues, unless there is an overriding reason to do so at the request of the Owners Representative.
- D. Re-testing:
 - 1. If a Functional Performance Test fails, corrections shall be made to the deficient equipment or systems by the Contractors. The systems will be re-tested until they pass the Tests.
 - 2. The time/cost for the CxA to perform any re-testing required because of improper set up of the systems by the contractors or failed functional or performance tests will be back-charged to the Contractor (who may choose to recover costs from the party responsible for executing faulty equipment start-up/checkout and associated checklists). This includes instances where a specific item was overlooked in the equipment start-up and checkout procedures, reported to have been successfully completed, but determined during Functional Performance testing to be faulty.
 - 3. Any required re-testing by any contractor, sub-contractor, or vendor shall not be considered a justified reason for a claim of delay or for a time extension by the Contractor.

3.5 Deficiencies and retesting

- A. The CxA documents the results of each test. (Corrections of minor installation or sequence of operation deficiencies are made during tests at the discretion of CxA.)
- B. Deficiencies/non-conformance issues not corrected during testing are reported to the Contractors for corrective action. Upon completion, a request is made by the Contractors to CxA for retest.

END OF SECTION 26 0800

SECTION 26 2200 ENERGY EFFICIENT TRANSFORMERS

PART1- GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to work specified in this section.

1.2 ENERGY EFFICIENT DRY-TYPE TRANSFORMERS

A. General: Dry type transformers shall be factory assembled, metal enclosed, provided complete with mounting brackets as required.

1.3 SUBMITTALS

- A. Shop Drawings: Shop drawings shall be submitted showing dimensions, wiring diagrams, taps and nameplate nomenclature.
- B. Product Data: Product data shall be submitted showing compliance with this section of the specification, manufacturer's written recommendation for storage and protection, and installation instructions.

1.4 PRODUCT STORAGE AND HANDLING

- A. Protection: Physically protect transformers against damage as recommended by manufacturer.
- B. Storage: A waterproof covering shall be kept around all transformers until they are ready to be energized.

1.5 SUBMITTALS

- A. General: Provide shop drawings and product data on transformer showing compliance with these specifications including:
 - 1. Pad dimensions with openings required.
 - 2. Complete dimensions and drawings on transformer.
 - 3. Coolant properties.
 - 4. Incoming compartment equipment.
 - 5. Accessories.

PART 2 - PRODUCTS

2.1 CONSTRUCTION – ENERGY EFFICIENT DRY TYPE TRANSFORMERS

A. Testing: Transformers shall be tested and rated for sound level in accordance with ASA-C89.1-1961.

- B. Listing: Dry type transformers shall be U.L. listed and certified to meet NEMA and ANSI standards. Additionally the transformer shall meet the efficiency requirements of NEMA TP-1 and the EPA Energy star program.
- C. Insulation: 220 degrees Celsius insulation shall be employed for transformers above 30 KVA with maximum temperature rise of 130 degrees C. over 40 degrees C. Class F insulation shall be employed for transformers up to and including 30 KVA with a maximum temperature rise of 115 degrees C. over 40 degrees C.
- D. Taps: Voltages shall be compatible with the application. Taps shall be provided two at plus 2-1/2 percent increments and two minus 2-1/2 percent increments from rated voltage.
- E. BIL: Basic impulse level shall be 90 KV.
- F. Windings: Windings shall be constructed of aluminum.
- G. Basis of Design: Square D energy efficient (EE) transformer.
- H. Alternate Manufacturers for Pricing: Provide alternate pricing for GE and Cutler-Hammer. No other manufacturers shall be permitted. Contractor shall submit proposals from all (3) approved vendors for Owner review and approval. Final selection shall be as directed by the Owner.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Mounting: Transformers shall be mounted where accessible. No units may be mounted behind partitions, above ceilings, etc. Each transformer shall be mounted on 3 inch concrete base extending 3 inches outside all sides.
- B. Noise Isolation: Flexible conduits shall be used to isolate noise.
- C. Grounding:
 - 1. Grounding and bonding shall be per NEC. Provide Grounding Electronic conductor run in minimum 3/4 inch conduit to local ground bar installation. Adjust conduit size as needed for specific ground wire sizes.
 - 2. Provide ground per NEC Section 250.

END OF SECTION 26 2200

SECTION 26 2416 PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work specified of this section.

1.2 **DESCRIPTION**

A. Description: Provide panelboards with main breaker or main lugs where shown on the drawings, of a dead front, distributed phase sequence design. Panelboards shall be equipped with thermal-magnetic molded case circuit breakers with frame and trip ratings as indicated in the schedules.

1.3 QUALITY ASSURANCE

- A. ANSI: the latest edition of the Reference Standards for the American National Standards Institute shall apply as follows;
 - 1. ANSI Y32.2 Graphic Symbols for Electrical and Electronic Diagrams.
 - 2. ANSI Z55.1 (R1973) Gray finishes for Industrial Apparatus and Equipment.
- B. NEMA: National Electrical Manufacturers Association shall apply as follows;
 - 1. NEMA PB1-1984 Panelboards
 - 2. NEMA PB1-57 Gutter space
- C. NFPA: The latest edition of the National Fire Protection Association shall apply as follows;
 - 1. NFPA-70 National Electrical Code.
- D. UL: The latest edition of the Underwriters' Laboratories, Incorporated shall apply as follows;
 - 1. UL Electrical Construction Materials List, panelboards-dead front type.
 - 2. UL 67 Panelboard wiring gutter space, bus heat rise test.
 - 3. UL 50 Cabinets Rigidity and gauge of steel.
- E. Listing: Panelboards shall be listed by Underwriters Laboratories and bear the UL or other nationally recognized testing laboratory label. Where required, panelboards shall be listed for use as service entrance equipment.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. Product data shall be submitted on:
 - a. Panel
 - b. Cabinet
 - c. Bus

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

TLC Engineering Solutions

Project No. 121505 Panelboards Section 26 2416 - 1

- d. Construction
- e. Dimensions
- 2. Shop drawings shall be submitted for every panel, and shall clearly indicate all of the following information:
 - a. U.L. Label
 - b. Each circuit breaker amperage rating, circuit number and position/location in panel
 - c. Electrical characteristics of panel
 - d. Main bus rating
 - e. Main device rating
 - f. Mounting type
 - g. Dimensions, (width, depth, height, weight)
 - h. Bus material
 - i. Interrupting capacity of minimum rated breaker
 - j. Panelboard classification
 - k. Submit coordination curves on log-log paper for all breakers, fuses, transformers, etc.
 - I. $\frac{1}{2}$ " = 1'0" electrical room plans per specification section 26 0100-2.2.9.

1.5 COORDINATION STUDY

A. The coordination study utilizes specific Square D circuit breakers. If another manufacturer or alternate Square D breaker types is submitted, contractor shall be responsible to provide a complete coordination study plotted on a time current curve (created in SKM) to ensure coordination throughout the system.

1.6 OVERCURRENT PROTECTIVE DEVICES - DESCRIPTION

A. Description of System: Connections of all items using electric power shall be included under this division of the specifications, including necessary wire, conduit, circuit protection, disconnects and accessories. Securing of roughing-in drawings and connection information for equipment involved shall also be included under this division. See other divisions for specifications for electrically operated equipment. Provide overcurrent protection for all wiring and equipment in accordance with the NEC, all federal, state and local codes as required and/or as shown on the drawings.

1.7 OVERCURRENT PROTECTIVE DEVICES - SUBMITTALS

- A. Shop drawings and product data: Shop drawings shall clearly indicate;
 - 1. Frame sizes and interrupting capacity of all circuit breakers.
 - 2. Horsepower ratings of rated voltage of circuit breakers.
 - 3. Device is U.L. Listed, and bears the U.L. Label.
 - 4. Device complies with these specifications, drawings, and applicable standards of NEMA, IEEE, ANSI, and ASA.

PART 2 - PRODUCTS

2.1 PANELBOARDS

- A. Equipment: The panelboard bus assembly shall be enclosed in a steel cabinet and shall be surface or flush mounted as shown in the schedules. The box shall be fabricated from galvanized steel with standard baked enamel finish. Panelboard front shall include a door and shall have a flush, cylinder tumbler-type lock with catch and spring-loaded stainless steel door pull. All panelboard locks shall be keyed alike. All panel cabinets shall be a minimum of 20 inches wide. Fronts shall have adjustable indicating trim clamps which shall be completely concealed when the doors are closed. Doors shall be mounted with completely concealed steel hinges. Panel front shall not be removable with door in the locked position.
 - 1. Provide all panels with "Door-in-Door" feature to allow full access to the interior wiring compartment without the complete removal of the panel trim.
- B. Bus: Panelboard bus structure and main lugs or main circuit breaker shall have current ratings as shown on the panelboard schedule. Bus shall be insulated and bus bar connections to the branch circuit breakers shall be of the "distributed phase" or phase sequence type. All current carrying parts of the bus structure shall be tin plated copper. A full size insulated neutral bus bar shall be provided. Provide system grounding tin plated copper bus bar bonded to the panelboard cabinet for connection of system grounding conductors. This bar shall be mechanically and electrically isolated from the neutral bar except where panelboard is used as service entrance equipment.
- C. Molded Case Circuit Breakers: All panelboard branch circuit breakers shall be plug-in style thermal-magnetic molded case type. Breakers shall be 1, 2 or 3 pole with an integral crossbar to assure simultaneous opening of all poles in multi-pole circuit breakers. Breakers shall have an overcenter, trip-free, toggle-type operating mechanism with quick-make, quick-break action and active handle indication. Handles shall have "ON", "OFF", and "TRIPPED" positions. Bolt-on circuit breakers shall be able to be installed in the panelboard without requiring additional mounting hardware.
- D. Solid State Circuit Breakers: Provide solid state circuit breakers for all breakers 125 amperes and above. Breakers shall have adjustable settings for long time pickup, long time delay, short-time pickup and short time delay. Refer to panel schedules and coordination study for exact circuit breaker requirements.
- E. 120/208 Rating: 120/208 volt circuit breakers shall have interrupting ratings a minimum of 10,000 rms symmetrical amperes at 240 volts AC maximum.
- F. 277/480 Rating: 277/480 volt circuit breakers shall have interrupting ratings a minimum of 14,000 rms symmetrical amperes minimum at 277 volts AC (single pole) or 480Y/277 volts AC 2 and 3 pole.
- G. Directories: A typed panelboard directory shall be provided for each panelboard and shall indicate the actual circuit number used, room name and type of load. Room names shall be the actual name or room number used not necessarily as shown on the drawing. Panel directories shall include all room numbers and names. Where panel schedules are indicated on the drawings as "receptacles or "lighting", etc., it shall be the responsibility of the Contractor to include the specific area served.
- H. Bracing: Panelboard as a complete unit shall be braced for a minimum short circuit rating equal to or greater than the lowest breaker symmetrical interrupting capacity as

shown on the schedule. However, all panelboards shall be fully rated. No series ratings are allowed.

- I. Grounding: All panelboard cabinets shall have a system grounding bar bonded to the panelboard cabinet for connection of system grounding conductors. This bar shall be mechanically and electrically isolated from the neutral bar.
- J. Stubs: Provide four 3/4 inch conduits from all flush mounted panels to adjacent accessible ceiling space and mark "for future use". Provide pull cord in all empty conduits and provide plastic end bushing.

K. Design Basis: Square "D"

<u>120/208V</u> Square "D", NQOD		480/277V Square "D", NF Series
<u>300A</u> Square "D": I-Line	<u>thru</u>	<u>1200A</u> Square "D": I-line

L. Alternate Manufacturers for Pricing: Provide alternate pricing for GE and Cutler-Hammer.

PART 3 - EXECUTION

3.1 INSPECTION

- A. General: Examine area to receive panelboard and assure that there are adequate clearances to meet NEC requirements and normal maintenance issues.
- B. Correction: Start work only after any unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Provide panelboards in complete accordance with manufacturer's written instructions and all applicable codes.
- B. Support: Panelboards shall be rigidly supported and installed per manufacturers recommended supporting instructions, with beams provided if necessary, to suit actual site conditions. Panels shall not be directly mounted to masonry walls. Use kindorf or similar channel.
- C. Storage and Delivery: Panelboards shall be delivered to the site during that phase of panelboard installation in order to avoid storing panels on site where damage may occur. Replace any damaged parts prior to energizing panel. Cover panelboard to avoid damage to finish.
- D. Mounting: Do not mount equipment directly to masonry or concrete walls. Provide two uni-strut spacers between wall and panelboard.
- E. Connections: Tighten bus connections and mechanical fasteners. Clearly mark on the bus and bolt connections the location of manufacturer's required torque and torque amount. Use of a black indelible marker on the bus bar is permitted.

F. Operations and Maintenance Data: Manufacturer's instructions for tightening bus connections, cleaning, operation and maintenance.

3.3 QUALITY CONTROL

- A. General: Field test prior to energization;
 - 1. Megger check, and record all data, of phase to phase and phase to ground insulation levels.
 - 2. Continuity.
 - 3. Proper phase relationship.

3.4 CHECK-OUT MEMO

A. General: Submit check-out memo from panelboard representative.

END OF SECTION 26 2416

SECTION 26 2726 WIRING DEVICES

PART1- GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to this section.

1.2 DESCRIPTION

- A. General: Provide factory fabricated wiring devices in type, color and electrical rating for the service indicated to provide convenient access to the electrical system for portable and permanent connections, and control of fixed outlets.
- B. Ratings: Voltage and ampere rating of switches and receptacles shall be marked on the device, and shall conform to Voltage and Ampacity of system to which applied.
- C. Hardware: Devices consist of all the necessary hardware to complete an installation and provide a margin of safety by inaccessibility of live electrical components.

1.3 WALL DIMMING CONTROLS

- A. General: LED Provide 0-10V dimming controls as indicated on drawings, and as specified herein to provide complete method of controlling the artificial illumination intensity portion of the project indicated. Provide dimmers, controls, interfaces, and ancillary equipment, dimming ballast, magnetic or electronic for use with specific control, to make a complete dimming system. Devices shall be slide.
- B. Standards: Voltage and ampere rating of dimmer controls shall be marked on dimmer, and shall conform to voltage of system to which applied.
 - 1. WD-2-1970 for dimmers.
 - 2. ANSI/IEEE Standard C62.41-1980
 - a. Test withstand voltage surges of up to 6000 Volts and current surges of up to 200 Amps for dimmers without damage.
 - 3. Nema WD-1
 - 4. UL 20
- C. Dimming Controls Quality Assurance:
 - 1. Manufacturers: Firms regularly engaged in manufacture of wiring devices, of types and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years. Fully test all dimmers for proper operation prior to shipment from the factory.
 - 2. Installer: A firm with at least 5 years of successful installation experience on projects with electrical installation work similar to that required for the project.
 - 3. Warranty: Provide a minimum one-year warranty from time of installation acceptance.

1.4 RECEPTACLES AND SWITCHES QUALITY ASSURANCE

- A. Manufacturers: Manufacturers shall be companies regularly engaged in manufacture of wiring devices, of types and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer: A firm with at least 5 years of successful installation experience on projects with electrical installation work similar to that required for the project.
- C. Compliance: Comply with the latest edition of the following standards;
 - 1. NEMA WD1, WD3 and WD5
 - 2. UL 5, 20 and 231
 - 3. UL 498 Hospital Grade Receptacle (Straight Blade Only)
 - 4. UL 1449
 - 5. FEDERAL SPECIFICATIONS UL HOSPITAL GRADE ABRUPT REMOVAL TEST
 - a. Using cable and 10 pound weight.
 - 6. ANSI/IEEE Standard C62.41-1980 (Formerly IEEE 587)
 - a. Test withstand voltage surges of up to 6000 volts and current surges of up to 200 amperes without damage.
- D. Warranty: Provide a minimum one-year warranty from time of final acceptance.

1.5 SUBMITTALS

- A. Wiring Devices: Submit manufacturer's product data on all wiring devices listed on the drawings including;
 - 1. Colors
 - 2. Dimensions
 - 3. U.L. Label
 - 4. Finish
 - 5. Voltage
 - 6. Wiring diagrams
 - 7. Application information
- B. Coverplates and Identification: Submit type of identification used for coverplates to comply with the Identification Section as specified herein. Screws to match coverplate color.

1.6 SEQUENCING AND SCHEDULING

A. Coordination: Coordinate with other work including wires/cables, electrical boxes and fittings, and raceways, to properly interface installation of all wiring devices.

PART 2 - PRODUCTS

2.1 DIMMING

- A. Color: Unless otherwise noted, standard device and matching faceplate color shall be as specified in other sections. Match colors with other devices, particularly when multi-gang application requires devices by other manufacturers.
- B. Dimensions: Profile projection off the wall of dimmer shall not exceed 0.295 inches beyond the surface of the wall. Dimmers in excess of 1500 watts shall not exceed 0.627 inches. Dimmer shall not exceed 2-3/4 inches in width for units 1000 watts or less and 4-1/2 inches for 1500 watt units. The height of all wattage units shall not exceed 4 1/2 inches. Depth of dimmer within backbox shall not exceed the following;
 - 1. 1-5/16 inches for units 1000 watts and lower.
 - 2. 1-5/8 inches for 1500 watt units.
 - 3. Selected low voltage and 2-location dimmers may exceed the above depth, but shall in no case exceed 1-11/16 inches.
 - 4. All dimmers within the same room or vicinity shall be of the same profile projection. Varying depths or projections shall not be tolerated.
- C. Mounting: Dimmers shall be mounted individually in a single gang standard switchbox, and be gangable without removing side sections (fins) or derating each unit's capacity.
- D. Operation: No auxiliary dimmers cabinets, control modules, or interfaces shall be required for operation at single location dimming of 2000 watts or less systems. 3-way dimmers shall be 3-way not one master and one slave.
- E. Rating: All devices shall be capable of operating at rated capacity indicated on the drawings without affecting rated lifetime.
- F. Temperature: Dimmers shall be capable of operating in an ambient temperature of 0 to 40 degrees C. (30 to 104 degrees F.)
- G. Static Discharge: Dimmers shall not be susceptible to damage or loss of memory due to static discharge.
- H. Short Circuit Test: Dimmers shall meet the UL 20 short circuit test requirement for snap switches.
- I. Filtering: Dimmers shall utilize an LC filtering network to minimize interference with properly installed radio, audio, and video equipment. Provide heavy duty toroidal choke to suppress RFI interference.
- J. Linear Slide Dimmers: Linear Slider Preset Systems Operation shall provide a continuous linear slider movement, which controls lighting intensity in direct proportion to the movement of the slider. Provide a smooth and continuous Square Law Dimming curve. Slider shall be of the dual wiping type, with a smooth movement, and an even pressure requirement for movement along the entire length of the slider. Encase the slider within the dimmer enclosure to prevent accumulation of dust on the control movement.

- K. Power-Failure Memory: When power is interrupted and subsequently returned, the lights shall come back on to the same levels set prior to the power interruption. Restoration to some other default or pre-set point is not acceptable, unless specifically noted elsewhere.
- L. Regulation: Regulate voltage so that a 10 percent variation in the line voltage shall cause no more than a 5 percent variation in the load voltage when the dimmer is operating at 40 volts (5 percent light output).
- M. Full-On Bypass: Dimmer shall contain latching contacts to bypass dimming circuitry when placed in the full on position to achieve 100 percent lighting output.
- N. LED Dimming: LED dimmers shall be rated at 120 volts or 277 volts as required.
 - 1. Operation: Dimming operation and performance shall be as follows;
 - a. Dimming range from 100 to 1 percent light output
 - b. Multi-LED fixture packs shall track evenly, with no perceptible difference in light levels for the same type lamps.
 - c. Different lengths of LED fixtures shall track evenly, with no perceptible difference in light levels for the same type of LED.
 - d. Fixture packs shall be inaudible with no apparent humming or buzzing at any point in the dimming range.
 - e. Warrantee does not become effective until after system is "seasoned" by 100 hour burning time.
 - 2. Electrical noise shall be suppressed to a level that shall not interfere with the normal operation of other properly designed and installed electrical equipment.
 - 3. Minimum light levels shall be user-adjustable in order to compensate for different loading of each dimmer.
 - 4. Use and interface control where necessary for preset systems, or for two location dimming of fluorescent fixtures.
- O. Dimmer Faceplates: Faceplates shall snap on to device with no visible means of attachment. Heat fins shall not be visible on front of device.
- P. Multigang: Using 2 or more dimmers and/or other wiring devices together. Include mounting frame for proper device alignment and faceplate attachment. Dimmers ganged with other devices in a common location shall be included under a single faceplate of the size and shape to accept all devices located in the ganged mounting. Utilize similar shaped wiring devices to dimmer configuration to keep alignment and appearance uniform.
- Q. Materials: Color and finish to be selected by the Architect/Engineer unless otherwise noted on the plans, or in these specifications.
- R. Dimmers shall be as that manufactured by Lutron Electronics Co., Hubbell Manufacturing Co., or Leviton Manufacturing.
 - 1. Design Selection: Lutron Nova Diva series.

2.2 CONVENIENCE RECEPTACLES

- A. Twenty Ampere Receptacles: Provide hospital grade single or duplex receptacles, 2-pole, 3-wire grounding, with green hexagonal equipment ground screw, ground terminals and poles internally connected to mounting yoke, 20 ampere, 120 volts, with metal plaster ears, side wiring, NEMA configuration 5-20R unless otherwise indicated.
- B. USB Charging Receptacles: Provide hospital grade duplex receptacles, 2-pole, 3-wire grounding, with green hexagonal equipment ground screw, ground terminals and poles internally connected to mounting yoke, 20 ampere, 120 volts, with metal plaster ears, side wiring, NEMA configuration 5-20R unless otherwise indicated. Device shall include (2) 5VDC, 2.0A type A USB chargers.
- C. Color: Devices connected to the normal system shall be ivory in color, unless otherwise noted. Devices connected to the emergency system shall be red in color unless otherwise noted.
- D. Device Type: Unless otherwise noted, provide all receptacles as the duplex modular type.
- E. Construction: Heavy duty nylon face and wraparound mounting strap, locked into and on the body, utilizing heavy-gauge brass ground contacts riveted to strap. Include automatic self-grounding spring to assure ground continuity between mounting strap and metal wall box. T-slot one piece copper alloy contact wipes which interface with plug blades inserted at 3 points. Line terminals shall be screw terminals and accept #14 to #10 AWG copper conductors.
- F. Hospital Grade Receptacles shall have a green dot located on the face of the device, indicating compliance with the Fed Spec UL listed above.
- G. Ground Fault Circuit Interrupter: Provide hospital grade, duplex, ground fault circuit interrupter receptacles, grounding type, UL rated Class A, Group 1, 20 ampere ratings, 125 volts, 60 Hz; with solid state ground fault sensing and signaling; with 5 milliampere ground fault trip level; equipped with 20 ampere receptacle configuration, NEMA 5-20R. Device shall contain test and reset pushbuttons, with a visual display of the tripped position. All outside receptacles (weatherproof) shall be duplex G.F.C.I. type. Interrupter shall resist tripping from the effects of radio frequency (RF) signals from 10 to 450 MHz.
- H. Manufacturer: Manufacturer shall be Pass & Seymour, Leviton or Hubbell.

2.3 TRANSIENT VOLTAGE SURGE SUPPRESSOR RECEPTACLE

- A. Modes of Protection: Surge suppression devices shall supervise Line to Neutral, Line to Ground, and Neutral to Ground conditions.
- B. Energy Capacities: The surge suppression device shall have equal surge protection of not more than 140 Joules of energy absorption in each mode, 3,000 amperes current handing in each mode, and 6000 volts protection in each mode.
- C. Noise Reduction: Provide device with EMI and RFI noise filters at an average of 7:1 noise reduction from 500 KHz to 30 MHz.
- D. Modular: Construct as a modular, heavy duty, Hospital Grade device.
- E. Identification: Each device shall have a long life LED diode covered by a wide angle viewing lens for positive identification of surge protection. Provide a zig-zag symbol on the face of the device.

- F. Response Time: Response time shall be not more than 5 Nanoseconds.
- G. Attenuation: Common mode noise attenuation shall be 500 KHz to 30 MHz; up to 35 db (50 ohm source impedance).
- H. Operating Temperature: Operating temperature shall be -20 to 55 degree C. (-4 to 131 degrees F.)
- I. Color: Devices connected to the normal system shall be ivory in color, unless otherwise noted. Devices connected to the emergency system shall be red in color unless otherwise noted.
- J. Manufacturer: Manufacturer shall be Pass & Seymour, Leviton or Hubbell

2.4 SWITCHES

- A. Toggle Switches: Provide specification grade, fast-make positive-break, flush single-pole, three and four way, silent operation toggle switches, 20 ampere, 120 volt AC or 277 volt AC as required, with mounting yoke insulated from mechanism, equipped with plaster ears, and side-wired screw terminals. Switches connected to the normal system shall be ivory; red for emergency system.
- B. Thermal Switch: Provide fractional horsepower switch with melting alloy type overload relay, with number of poles to coordinate with the equipment being controlled. Surface or flush mounted cover, as required, equipped with padlocking device and pilot light. Provide overload relay heaters for each pole of the switch, sized per the manufacturer's instruction, and adjust heater size to permit normal operation of the motor.
- C. Color: Devices connected to the normal system shall be ivory in color, unless otherwise noted. Devices connected to the emergency system shall be red in color unless otherwise noted.
- D. Manufacturer: Manufacturer shall be Pass & Seymour, Leviton or Hubbell.

2.5 PLUGS AND CONNECTORS

A. Standard: Comply with NEMA Standards Pub. No. WD1.

2.6 WIRING DEVICE ACCESSORIES

- A. Faceplates: Faceplates for interior outlets in "Medical Facilities", connected to normal or essential power supply system shall be plastic. Color of faceplate shall match color of device ivory for normal power and red for emergency power.
- B. Multigang: Provide all necessary hardware and frames to properly mount various devices in combinations.
- C. Weatherproof Device Covers: For all receptacles installed outdoors and/or in wet locations, provide a weatherproof enclosure in full compliance with NEC Article 406.8B. Enclosure shall be weatherproof, whether or not the attachment plug cap is inserted. Covers to be heavy duty diecast similar to Intermatic WP1010 series.

PART 3 - EXECUTION

3.1 INSTALLATION OF WIRING DEVICES

- A. General: Provide wiring devices, in accordance with manufacturer's written instructions, applicable requirements of NEC and National Electrical Contractors Associations "Standard of Installation", and in accordance with recognized industry practices to ensure that products serve intended function.
- B. Completion: Delay installation of devices until wiring and wall finish is completed.
- C. Support: Devices shall be securely supported to box, not supported to device plate. Device shall trim out flush with front of plate. Do not support the device by loosening device mounting screws and attaching the coverplate for leveling.
- D. Adjustment: Provide receptacles and switches only in electrical boxes which are clean, free from excess building materials, debris, etc. Adjust devices to plumb when tightened, and in position to receive faceplate. Devices shall not be leveled by using the mounting screws, outlet boxes shall be flush to wall finish prevent leveling problems. Tighten devices and provide securely, so that there shall be no movement during usage.
- E. Position: Position ground pin at the top of the device in vertical application, unless otherwise noted.
- F. Wiring: Provide screw terminal connections using a single conductor only. Do not "backstab" devices. Provide single whips for multiple conductor connections within each box.

3.2 WALL DIMMER INSTALLATION

- A. General: Provide dimmers in accordance with manufacturer's written application, wiring, and installation instructions. Applicable requirements of NEC and National Electrical Contractors Associations "Standard of Installation", and in accordance with recognized industry practices to ensure that products serve intended function.
- B. Mounting: Provide dimmers only in electrical boxes which are clean and free from excess building materials, debris, etc. Adjust dimmers to plumb when tightened, and in position to receive faceplate. Tighten dimmers so that there shall be no movement during usage.
- C. Cover Plates: Provide dimmers and cover plates in true vertical or horizontal alignment as applicable. Plates shall be properly secured by means of screws which have heads with finish matching the plate. Secure plates so as to maintain a snug fit against dimmer surfaces, with no gaps.

3.3 APPLICATION OF COVER PLATES

- A. Mounting: Provide coverplates in true vertical or horizontal alignment as applicable. Plates shall be properly secured by means of screws which have heads with finish matching the plate. Secure plates so as to maintain a snug fit against wall surfaces with no gaps.
- B. Replacement: Replace all coverplates which are warped, cracked, chipped, or whose color does not match the balance of the installation. Replace screws whose threads do not allow the drawing up tight of the coverplate to the device.

3.4 CLEANING

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 121505 Wiring Devices Section 26 2726 - 7

- A. Soiled Devices: Clean devices soiled prior to acceptance inspection, to remove all debris and foreign materials, such as paint, varnish, drywall compound, etc.
- B. Solutions: Do not use liquid cleaning solutions, etc. on the face of the devices without written direction from the Engineer/Architect.

3.5 TESTING

- A. Ground testing: Provide ground testing procedures as specified herein. Prior to energizing circuitry, test wiring devices for electrical continuity, and for short circuits.
- B. Polarity: Subsequent to energization, test wiring devices for proper polarity, and to demonstrate operations as required in this and other sections of this Specification.
- C. Recording: Record all tests as required in other sections of this specification.

END OF DOCUMENT 26 2726

SECTION 26 2816 SAFETY SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 specification sections, apply to work specified of this section.

1.2 QUALITY ASSURANCE

A. General: Switches and all components shall be manufactured and tested in accordance with the latest applicable standards of NEMA and UL.

1.3 SUBMITTALS

- A. Shop drawings: Product data shall be submitted on:
 - 1. Switch rating, including voltage, continuous current, short-circuit.
 - 2. Fuse ratings, when applicable.
 - 3. Cable terminal sizes.
 - 4. Enclosure type.
 - 5. Conduit entry/exit locations.

PART 2 - PRODUCTS

2.1 HEAVY DUTY SAFETY SWITCHES

- A. General: All disconnect switches shall be heavy-duty type, unless specifically noted otherwise. Switches shall be fusible or non-fusible and sized as noted on the drawings. Provide units manufactured by Square D. (No substitutions)
- B. Switches shall be 240 volt rated on systems up to and including 120/240V and 600V rated on higher voltage systems. All switches serving motor loads or 600V rated shall be horsepower rated.
- C. Provide NEMA 1 enclosure, unless otherwise noted. All switches mounted outdoors shall be NEMA Type 4X, stainless steel, unless noted otherwise.
- D. Provide lugs on disconnect switch as required to accept conductors called for on drawings.
- E. Provide switches with an externally operated handle; quick make quick break mechanism; the handle shall be interlocked with the switch cover by means of a defeatable interlock device. The switch shall be lockable in the "off" position with a padlock.
- F. Switches shall have arc suppressors and pin hinges. Switch blades shall be readily visible in the OFF position. Switch blades and jaws shall be plated copper. Provide with line side terminal shields.
G. Variable Frequency Drives: When used downstream of variable frequency drives, provide safety switch with auxiliary contacts wired back to the VFD safety control circuit to remotely shutdown the VFD when the safety switch is actuated.

2.2 FUSES

- A. General: All fuses shall be of the same manufacture to retain selectability as designed. No fuse shall be installed until equipment is ready to be energized and after tightening of all electrical connections, inspection of all ground and grounding conductors and a megger test of adequate insulation to ground of all circuits.
- B. Current Limiting: All fuses shall be current-limiting with 200,000 amperes interrupting capacity.
- C. 600 Amps and Below: Fuses rated 600 amperes or less, installed ahead of circuit breakers or circuit breaker panels, shall be UL Class K-1. Fuses rated 600 amperes or less for all general power circuits shall be dual-element, UL Class K-5 time-delay type. They shall be self protecting from extraneous heat.
- D. Motor Circuits: Fuses installed in individual motor circuits shall be dual element timedelay type, UL Class K-5. Use fuse reducers when fuse clip spacing is larger than the fuse dimension.
- E. Rejection Fuses: Fuses called for to be rejection type are to have rejection fuse holders.
- F. Spare Fuses: Ten percent or minimum of three, whichever is greater, of each size and type of fuse, including control power or control transformer fuses, shall be placed in a spare fuse cabinet, wall mounted near the electric service.
- G. Spare Fuse Cabinet: Cabinet shall be sized as required to store all fuses neatly. Cabinet shall contain shelves and/or slots as required to separate types of fuses. Cabinet door shall be hinged with latch and be located in the main Normal Electrical Room.
- H. Identification Label: A fuse identification label, showing type and size, shall be placed inside the door of each fused switch. Labeling for rejection type fused switches shall read "Warning-Use Only Current Limiting Fuses Class ____, Type ____, MFR ____," engraved in red laminated plastic.

PART 3 - EXECUTION

3.1 INSPECTION

- A. General: Examine area to receive safety switch and assure that there is adequate clearances to meet NEC requirements and normal maintenance issues.
- B. Correction: Start work only after any unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Provide safety switches in complete accordance with manufacturer's written instructions and all applicable codes.

- B. Support: Switches shall be rigidly supported and installed per manufacturers recommended supporting instructions. Switches shall not be directly mounted to masonry walls; Use Kindorf, uni-strut or similar support.
- C. Storage and Delivery: Safety switches shall be delivered to the site during that phase of installation in order to avoid storing switches on site where damage may occur. Replace any damaged parts prior to energizing. Cover to avoid damage to finish.
- D. Operations and Maintenance Data: Manufacturer's instructions for tightening connections, cleaning, operation and maintenance.

3.3 ADJUSTMENT AND CLEANING

- A. General: Adjust operating mechanisms for free mechanical movement.
- B. Connections: Tighten lug connections and mechanical fasteners.
- C. Finish: Touch-up scratched or marred surfaces to match original finish.

END OF SECTION 26 2816

SECTION 26 2913 MOTOR CONTROLLERS

PART1- GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work specified of this section.

1.2 QUALITY ASSURANCE

- A. Compliance: Materials shall comply with the latest edition of the following standards as they apply to the different motor control types.
- B. ANSI: The latest edition of the Reference Standards for the American National Standards Institute shall apply as follows;
 - 1. ANSI Y32.2, Graphic Symbols for Electrical and Electronic Diagrams.
 - 2. ANSI Z55.1 (R1973) Gray finishes for Industrial Apparatus and Equipment.
- C. NEMA: National Electrical Manufacturers Association shall apply as follows:
 - 1. NEMA ICS-1, 2, 3, 4, 5, 6, controls and systems.
- D. NFPA: The latest adopted edition of the National Fire Protection Association shall apply as follows:
 - 1. NFPA-70 (2011) National Electrical Code
- E. UL: The latest edition of the Underwriters' Laboratories, Incorporated shall apply as follows:
 - 1. UL Electrical Construction Materials List, motor controllers.

1.3 INSTALLATION OF MOTOR CONTROL EQUIPMENT

- A. Responsibility: Unless specifically noted otherwise, motor controllers for all equipment requiring them shall be installed as part of this Division in conformance with other Sections of the specifications. Mechanical equipment, which has packaged starters, shall have controllers supplied with the mechanical equipment.
- B. Manufacturer: All starters shall be of the same manufacturer Square "D". (No substitutions.)

1.4 DESCRIPTION OF SYSTEM

A. Description: Motor controllers shall be factory-assembled, metal-enclosed motor control units for distribution and control of power from incoming line terminals to outgoing feeder terminals, installed and tested in place.

Project No. 121505 Motor Controllers Section 26 2913 - 1 B. Provisions: Motor Controllers shall include all protective devices and equipment as listed on drawings or as included in these specifications, with necessary interconnections, instrumentation, and control wiring.

1.5 SUBMITTALS

- A. Products: Submit manufacturer's product data, including technical information on each type of motor control as follows;
 - 1. Individually mounted AC Magnetic Starters: Shop Drawings shall clearly indicate:
 - a. Frame sizes and Interrupting Capacity of starter and/or disconnect unit.
 - b. Horsepower rating at rated voltage of starter and/or disconnect unit.
 - c. Electrical ratings.
 - d. Single line diagram for power and control connections with numbered terminals and all required accessories.
 - e. All required accessories.
 - f. Manufacturer's written recommendation for storage and protection, installation instructions and field test requirements.
- B. Test Reports: Provide reports of all production and field tests. Tests shall include rated continuous and short circuit currents, dielectric, grounding, operation and control.
- C. Operations and Maintenance Data: Provide manufacturer's instructions for tightening bus connections, performing cleaning, and operating and maintaining motor control unit.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Accessories: Controllers shall be equipped with auxiliary contacts, as required for proper control functions, minimum of two normally open auxiliary contacts, in addition to the normally open auxiliary seal-in interlock and shall be suitable for the addition of at least two additional external electrical interlocks, one normally open and one normally closed. All starters shall have green "run" and red "off" pilot lights, "Hand-Off-Auto" selector switch, and nameplate. Control voltage shall be as required. Starters shall contain fused control transformers to provide correct control voltage.
- B. Power Monitor: For 3-phase motors 5hp and above, controller shall include three-phase power monitor equal to Time Mark Corporation Model #A258B, for 480V, 3 phase systems providing solid-state protection by opening starter for loss of any phase, low voltage of any or all phases, and phase reversal. Monitor shall be field adjustable for drop-out voltage of 340-480 VAC. Provide monitor with auto-reset.
- C. Doors and Interlocks: Controller doors shall be interlocked mechanically with the unit disconnect device to prevent unintentional opening of the door while energized and unintentional application of power when door is open. Means shall be provided for releasing the interlock for intentional access to the interior at any time and intentional application of power, if desired, while door is open. Padlocking arrangements shall permit locking the disconnect device OFF with at least three padlocks with door closed or open. Unit disconnect operating handle shall be mounted on the disconnect, not on the unit door and shall indicate ON and OFF with door open or closed. Solid State Overload relays shall be reset from outside the enclosure by means of an insulated bar or button.

Project No. 121505 Motor Controllers Section 26 2913 - 2 Auxiliary switch shall be included with the disconnect switch to disconnect control circuit when the disconnect is opened.

- D. Controller Ratings: Controllers shall be rated in accordance with NEMA sizes and horsepower ratings. All controllers shall be gravity dropout. All controllers shall have solid state overload contacts. All contacts must be capable of being inspected, and must be removable, without removing line or load wiring. Coils on starters, size 5 and smaller, shall be molded construction. On size 6 and larger, coils may be form wound, taped, varnished and baked.
- E. Control Voltage: Each controller shall contain fused control transformer to provide correct control voltage. Control voltage shall be as required. Furnish control transformers as required.
- F. Internal Control Wiring: Each control wiring conductor shall have heat shrink identification labels on each end of termination. Terminations shall be made to screw terminal strips. All points of terminal strips are to be labeled to match conductor labeling.
- G. Withstand ratings: Complete controller assemble shall have rating equal to or greater than available fault current, but in no case less than 65,000 amperes for 3-cycles.

2.2 ACROSS-THE-LINE MAGNETIC CONTROLLERS

- A. Combination Starter and Disconnect: Combination starters and disconnect switches shall be a combination across-the-line magnetic type starter with motor short-circuit protector (magnetic only breaker) disconnect, rated in accordance with NEMA Standards, sizes and horsepower rating. Final magnetic setting of MCP shall be field set and recorded. Unit shall be mounted on NEMA I enclosures, unless otherwise noted.
- B. General: Starters shall be equipped with solid state electronic type overloads, with adjustable settings from the front without removing starter from enclosure. Thermal units are not acceptable.

2.3 ENCLOSURES

- A. Two (2) ground lugs shall be furnished, one (1) for incoming and one (1) for outgoing ground connections.
- B. Power terminations shall consist of pressure-type terminals for top or bottom entrance.
- C. NEMA Rating: Unit shall be supplied as NEMA 1 enclosed, unless otherwise noted. All enclosures mounted outdoors shall be NEMA Type 3R or as noted NEMA Type 4X stainless steel.
- D. Gauge: Enclosures shall not be less than 16-gauge steel. Type 12 enclosures shall be of welded construction with gasketed heat sink and doors.
- E. Operating Handle: The operating handle of the disconnect, when supplied, shall always remain connected to the breaker or switch. The operating handle shall not be mounted on the door of the enclosure, but on the controller for safe "stand-aside" operation. The position of the operating handle will indicate ON or OFF position of switch or circuit breaker and include provision for padlocking in the OFF position.

Project No. 121505 Motor Controllers Section 26 2913 - 3

- F. Door Interlock: Interlock provisions shall prevent unauthorized opening or closing of the starter door with the disconnect in the ON position.
- G. Lifting Means: The structure, when floor-mounted, shall be provided with adequate lifting means and shall be capable of being rolled or lifted into installation position and bolted to the floor.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Coordination: Examine area to receive motor-control units to assure adequate clearance for motor control unit installation.
- B. Provision: Start work only after unsatisfactory conditions are corrected.

3.2 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Storage: Do not store indoor motor control units exposed to weather.
- B. Protection: Physically protect motor control units against damage from work of other trades. Cover motor control units with suitable material to avoid damage to finish.

3.3 INSTALLATION

A. General: Provide motor control units in accordance with manufacturer's written instructions, and the NEC.

3.4 FIELD QUALITY ASSURANCE

- A. Testing: Perform tests according to motor control unit manufacturer's instructions. Field tests prior to energizing as follows;
 - 1. Megger check of phase to phase to ground insulation levels.
 - 2. Continuity.
 - 3. Short Circuit.

3.5 ADJUSTMENT AND CLEANING

- A. General: Adjust operating mechanisms for free mechanical movement.
- B. Connections: Tighten bus connections and mechanical fasteners.
- C. Finish: Touch-up scratched or marred surfaces to match original finish.

3.6 CHECK-OUT MEMO

A. General: Submit check-out memo from motor controller manufacturer's representative.

END OF SECTION 26 2913

SECTION 26 3213 EXTERIOR ENGINE GENERATOR

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work specified of this section.

1.2 DESCRIPTION

A. General: This section describes materials, installation and testing of a UL2200 listed exterior located, sound attenuated engine generator set, with main breaker, thermal heat pump and auxiliary support system, to be used for in the event of a utility failure. Generators shall be "standby power rated".

1.3 GENERAL PROVISIONS

- A. Intent: It is the intent of these specifications to secure, for the purchaser, a diesel engine driven generator set of the latest commercial type and design as specified herein. All material and equipment shall be new and undamaged.
- B. Service: The engine-generator supplier shall maintain a local parts and 168 hour/week service facility located within a 100 mile radius of jobsite. The generator set supplier must have no less than 60 percent of all engine replacement parts in his stock within the State at all times. Certified proof of this requirement shall be available from the dealer, and a personal inspection of the dealer's facilities shall be made by the consulting engineer or his appointed representative to substantiate claims made by the generator set supplier. The supplier shall provide all installation and test supervision necessary for final acceptance and testing. The generator set supplier shall provide all equipment except underground fuel storage tanks and fuel piping. All power feeders and service entrance conductors and conduit. All generator control alarm and interlock wiring including conduit shall be completely provided by the Contractor. The Contractor shall be responsible for the generator set supplier and related requirements.

1.4 SUBMITTALS

- A. Shop Drawings: Submit shop drawings in accordance with Section 16010 of this specification.
- B. Submission: Show applicable ratings, sizes, materials, manufacturers and part numbers, and overall dimensions and weights, for the following equipment;
 - 1. Itemized bill of material
 - 2. Manufacturer and model of engine
 - 3. Manufacturer and model of generator
 - 4. Control panel
 - 5. Battery charger
 - 6. Batteries
 - 7. Governor
 - 8. Exhaust silencer
 - 9. Main line circuit breaker
 - 10. Sub-Base Fuel tank and isolators
 - 11. Remote annunciator panel
 - 12. Voltage regulator
 - 13. Jacket water heaters

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 121505 Exterior Engine Generator Section 26 3213 - 1

TLC Engineering Solutions

- 14. Fuel, lube oil and turbo charger intake air filters
- 15. System schematic diagram showing wiring interconnections with sizes and quantities.
- 16. Modification fact sheet giving fuel, coolant, lubricating oil, and exhaust and ventilation requirements.
- 17. Torsional vibration analysis for engine and generator.
- 18. NFPA 110 Factory Test Report.
- 19. A start-up inspection report signed by the engine manufacturer's authorized field service representative.
- 20. Provide an information copy of the standard engine inspection and maintenance service contract. The contract shall be for the complete system including all auxiliary support systems.
- 21. Éngine emissions
- 22. Complete generator and fuel tank assembly drawing showing completed installation and all dimensions.
- 23. Sound attenuated, weatherproof housing with location of batteries
- 24. Remote Shunt Trip Push Buttons
- 25. The name and location of parts and service facility which shall service equipment.
- 26. Parts and service as required in this section for engine and generator. Submit preventive maintenance program.
- 27. Manufacturer's Warranty
- 28. Bore, stroke, piston, speed and number of cylinders.
- 29. Engine displacement.
- 30. Temperature rise by resistance of both rotor and stator, maximum KVA and KW rating, generator efficiency, type of excitation, generator regulator and regular accessories.
- 31. Shop drawings on exhaust muffler and exhaust piping showing all parts, dimensions, and required mounting accessories.
- 32. Submit ½"x1'-0" layout of generator yard showing exact locations, sizes, and relationships of the generator(s) and all accessories, including silencer, and fuel tank.
- 33. Dimensions, installation, and connection requirements for generator units.
- 34. Ventilation and combustion air requirements for generator.

1.5 MANUFACTURER'S SERVICES

A. Manufacturer's Services: Provide authorized equipment manufacturer's services at the jobsite. Install equipment, check the modifications, supervise start-up, and supervise testing and adjustment of the equipment. Provide a minimum of two man-days to instruct the Owner's personnel in the operation and maintenance manuals prior to this instruction.

1.6 WARRANTY

A. Duration: Provide a 5 year comprehensive warranty covering all replacement parts and labor for al items provided in this section. Warranty period shall commence at time of Owner acceptance of generator(s).

PART 2 - MATERIALS

- 2.1 MANUFACTURERS
 - A. General: The units shall be the product of a firm regularly engaged in the manufacture of engine sets and shall meet the requirements of these specifications. It must be a standard model in regular production at the manufacturer's place of business. Engine, generator, and all accessories and control panels shall be serviced by the same supplier so that there shall be one source and one responsibility. Engines shall be manufactured within the continental United States.

- B. Basis of Design Manufacturer: Caterpillar #C15 packaged generator.
- C. Accepted Alternate Manufacturers: Cummins/Onan, or Kohler. Final selection of vendor shall be as directed by the Owner.
- D. Qualifications: The engine-generator manufacturer shall be an authorized full service dealer.

2.2 RATING

- A. General: The rating of the standby engine-generator shall be as listed below and based on operation when equipped with all operating accessories, including air cleaners, fans, lubricating oil pumps, fuel injection pump, and jacket water pump. The specified standby KW shall be rated for continuous electrical service during interruption of the normal utility source. The engine generator shall have the following ratings;
 - 1. Standby Rating 125 KW: 156 kVA
 - 2. Engine Speed: 1,800 RPM (maximum)
 - Voltage: 120/208 volts, 3 phase, 4 wire
 Frequency: 60 hertz

 - 5. Power Factor: .8
 - 6. Altitude: 100 feet above sea level, without de-rating standby rating
 - 7. Ambient temperature: 110 degrees F. maximum, 25 degrees F. minimum.

2.3 ENGINE

- A. General: Provide an engine with the following features;
 - 1. Full compression ignition diesel
 - 2. Four-stroke cycle
 - 3. Water cooled
 - Replaceable valve seat inserts 4.
 - Capable of the rated output when operating on a commercially available No. 2 diesel oil 5. (ASTM D 396).
 - 6. Capable of extended no load operation without loss of lubricating oil.
- B. Accessories: Provide the engine with the following accessories;
 - 1. Fuel, lube oil, and intake air filters
 - Intake air silencer, high frequency type 2.
 - Lube oil cooler 3.
 - 4. Flexible fuel lines
 - 5. Gear-driven water pump
 - Coolant and oil drain valves 6.
 - 7. Fuel priming pump
 - 8. Crankcase fumes disposal system
 - Engine control wiring multi-strand plastic insulated cable enclosed in nylon flexible slotted 9. conduit terminated in bulkhead fittings
 - Sound Attenuated Weatherproof engine generator set enclosure 10.
 - Sub-base Fuel Tank 11.

2.4 **GENERATOR STARTING**

A. Starting Motor: A DC electric starting system with positive engagement drive shall be provided. The motor voltage shall be as recommended by the engine manufacturer.

- B. Automatic Control: Fully automatic generator set start stop controls in the generator control panel shall be provided. Controls shall provide shutdown for low oil pressure, high water temperature, overspeed, overcrank, and two auxiliary contacts for activating accessory items. Controls shall include a 30 second single cranking cycle limit with lockout.
- C. Batteries: A nickel-cadmium storage battery to be used in conjunction with the electric starting system and generator control switchgear shall be provided for the engine. The batteries shall have sufficient capacity to provide for one minute total cranking time without recharging and shall be 12 hour rated. The battery shall be rated by the battery manufacturer in accordance with requirements set forth by the engine manufacturer. Provide a battery rack of fiberglass construction with bottom insert to insulate the batteries and prevent corrosion and necessary cables, clamps and replaceable connectors. Batteries shall be mounted in the building where shown and required. Wiring shall be sized as required by manufacturer for distance involved.
 - 1. Batteries shall be located within the weatherproof housing.
- D. Battery Charger: Current limiting battery charger shall be provided to automatically recharge batteries. Charger shall float at 1.4 volts per cell and equalize at 1.6 volts per cell. It shall include overload protection silicon diode full wave rectifiers, voltage surge suppressor, DC ammeter, DC voltmeter, and fused AC input. AC input voltage shall be 120 volts, single phase. Amperage output shall be no less than 20 amperes and size based on load of gear and recharge of battery in 24 hours. Charger shall be Lamarche model A46 or approved equal. Charger shall have auxiliary contacts to close on low voltage and N.O. AC input for connection to respective generator control cubicle in generator switchboard. Charger shall be capable of fully charging batteries during running conditions and shall be coordinated with generator provided.
 - 1. Battery charger shall be located within the weatherproof housing and shall be suitable for exterior applications.

2.5 GOVERNING SYSTEM

- A. Governor: Provide a Woodward 2301 or Barber Coleman equal, electronic adjustable isochronous governor with electronic speed sensing.
- B. Speed: Governor shall provide adjustable speed setting from 58 to 62 hertz and maintain the frequency within plus of minus 0.25 percent from no load to full load. Upon load change of not more than 25 percent of rated load, the governor shall re-establish stable operation in not less than one and one-half seconds. Stable operation is defined as operation at a frequency within plus of minus 0.25 percent of rated frequency.
- C. Tolerance: The maximum change of frequency during the one and one-half second load change surging period shall not exceed 0.5 Hz.
- D. Load Change: After any sudden load change of not more than 25 percent of rated load, the governor shall reestablish stable operating conditions in not less than 1-1/2 seconds. Stable operation is defined as operated at a frequency that is constant within plus or minus 0.25 percent of rated frequency.
- E. Maximum Change: The maximum change of frequency during the one-half second surging period shall not exceed 0.5 Hz.
- F. Location: Governor Module shall be mounted inside generator control panel.
- G. Actuator: The engine shall be equipped with a compatible actuator and the necessary magnetic pick-up to drive the governor.

- H. Cable: All connections between the engine governor, engine and switchgear auxiliary switching points shall be made with shielded cable.
- I. Cable Separation: Governor Cable shall not be run in the same conduit with AC control of primary voltages.

2.6 ENGINE GENERATOR ACCESSORIES

- A. Accessories: Cylinder Liners, Pistons, and Valves: Cylinder liners, pistons, and valves shall be as follows:
 - 1. The engine shall be provided with removable wet-type cylinder liners of close grained alloy iron, heat treated for proper hardness to obtain maximum life.
 - 2. Pistons shall be aluminum alloy with cast iron top ring banks and chrome-faced rings.
 - 3. Valve train shall employ replaceable valve seat inserts, alloy steel valves and cast iron guides.
- B. Lubrication: Lubrication shall be as follows:
 - 1. A gear-type lubricating oil pump shall supply oil under pressure to main bearings, crank pin bearings, pistons, timing gears, camshaft bearings and valve rocker mechanism.
 - 2. Pistons shall be spray cooled.
 - 3. Effective full flow lubricating oil filters shall be provided and so located that lubricating oil is continuously filtered except during periods when oil is by-passed to protect vital parts such as when filters are clogged.
 - 4. Replacement resin impregnated cellulose type filter elements shall be accessible and easily removable. Filter system shall be equipped with a spring-loaded bypass valve as an insurance against stoppage of lubricating oil circulation in event the filters become clogged.
 - 5. A suitable water-cooled, engine-mounted lubricating oil cooler shall be provided. The diesel oil sump drain shall be brought to the outside of the set for ease of changing oil.
- C. Air Cleaners: One or more engine-mounted dry type air cleaners of sufficient capacity to protect working parts of the engine from dust and grit shall be provided.
- D. Jacket Water Heater: Jacket water heater shall be as follows;
 - 1. Provide a unit-mounted thermal circulation-type water heater incorporating a self-contained thermostatic switch, controlled by the exit coolant temperature from the heater to maintain engine jacket coolant to 90 degree F.
 - 2. The heater shall be single phase, 60 Hz, 480 volts. Heater shall be Chromalox, or Kim-Hotstart, or approved equal. Provide breaker and circuit size as required for heater.
 - 3. Provide hand valves in the heater hoses to facilitate changing heating elements without draining the entire cooling system.
 - 4. Heater shall automatically disengage upon activation of the generator.

E. Duty Cycle: The engine shall be capable of operation at light loads for extended periods of time and shall provide for pre-combustion of fuel or a similar means for the prevention of carbonization.

2.7 FUEL SYSTEM

- A. Description: Fuel System Injection pumps and injection valves shall not require adjustment in service. The engine shall have an individual mechanical injection valve for each cylinder, any one of which may be removed and replaced from parts stock.
- B. Fuel injection pump shall be positive action, constant-stroke pumps, actuated by a cam driven by gears from the engine crankshaft. Fuel lines between injection pump and valves shall be heavy seamless tubing, and, to eliminate irregularity of fuel injections, shall be of the same length for all cylinders.
- C. Fuel system shall be equipped with replaceable fuel filter elements which may be easily removed without breaking any fuel line connections or disturbing the fuel pumps or any other part of the engine. Fuel filter shall include fuel pressure gauge, bypass valve (normally closed), manual shutoff valve.
- D. All fuel filters shall be conveniently located in one accessible housing, ahead of injection pump so that fuel shall have been thoroughly filtered before it reaches the pump. No screens or filters requiring cleaning or replacement shall be used in injection pump or injection valve assemblies.
- E. Engine shall be equipped with a built-in gear-type engine-driven fuel transfer pump, capable of lifting fuel against a head of 12 feet, for supplying fuel through the filters to the injection pump at constant pressure.
- F. Provide a water separator on the engine just ahead of the fuel filters constructed of heat-resistant glass, with aluminum-perforated baffle for viewing amount of water contained.
- G. Provide a fuel supply shut-off solenoid.
- H. Provide a low level alarm set at 48 hours full load consumption for sub-base fuel tank.

2.8 EXHAUST SYSTEM

- A. Description: Exhaust system shall consist of a critical silencer, Maxim M51, Donaldson TCU Series or approved equal, flexible exhaust fitting, exhaust piping, insulation, and mounting hardware.
- B. Silencer: Provide a critical type silencer constructed of mild steel. Exhaust noise shall not exceed 75 dBA at 25 feet. Provide brackets, companion flanges, gaskets, and fasteners.
- C. Fittings: Provide Type 316 stainless steel bellows-type flexible exhaust fitting at least 18 inches long.
- D. Discharge: Provide horizontal discharge tailpipe. Undercut at 45 degrees and cover with 80 percent expanded metal bird screen.

- E. Provide exhaust system consisting of adapters, elbows, lined bellows, piping, supports, drain tees, and support assemblies. The system shall be a custom-fitted fabrication.
- F. Pitch: Pitch horizontal runs of exhaust pipe away from the engine. Provide condensate traps with petcocks or valves at low spots in the exhaust system.
- G. Size: Inlet and outlet size shall be as recommended by manufacturer.

2.9 ACOUSTICAL TREATMENT

- A. General: The engine block and heads shall be provided with factory applied acoustical dampening. The amount and location of treatment shall be the normal available from the engine manufacturer. The exhaust manifolds, turbochargers and silencers shall be wrapped with HITCO A.I.M. flexible layered fiberglass blankets or accepted substitution supplied by engine manufacturer installed by the Contractor.
- 2.10 STRUCTURAL STEEL BASE
 - A. Base: Isolate the structural steel base from the engine with 6 quad spring-type isolators with neoprene-jacketed pre-compressed molded fiberglass noise isolation pads, steel load plate, built-in leveling bolt, welded steel or cast housing, and high deflection steel springs.
 - B. Isolators: Isolators shall be Peabody Noise Control, Inc.; Kinetics brand, Type SM; Norfund or Dynamics Corporation.
- 2.11 COOLING SYSTEM ENGINE MOUNTED RADIATOR
 - A. Radiator: Provide an engine-mounted radiator with blower-type fan sized to maintain rated full load continuously at the specified maximum ambient temperature. Fan rpm shall not exceed 819 rpm.
 - B. Coolant Switch: Equip the radiator with a 1 inch wide duct adapter flange and low coolant level switch with 1 N.O. and 1 N.C. contact.
 - C. Airflow: Airflow restriction from the radiator shall not exceed 0.50 inch water.
 - D. Fluid: Fill the engine cooling system with a solution of 30 percent by volume ethylene glycol with rust inhibitor.

2.12 REMOTE ANNUNCIATOR

- A. General: Provide a NFPA 110 Level 2 remote annunciator at location shown on drawings to annunciate generator alarms and pre-alarms as required by NFPA 110 and as specified herein.
- B. Mounting: Remote annunciator shall be flush mounted.
- C. Alarms: Remote annunciator shall mimic all alarms required at the generator control panel.
- D. Audible Annunciation: The remote annunciator shall have audible alarm annunciation, with a "silence" button. When an alarm is silenced, any new alarm shall automatically reinitiate the audible alarm.
- E. Power: Power for remote annunciator shall be provided from generator battery.

2.13 GENERATOR CONTROL PANEL (LOCATED ON THE EMERGENCY GENERATOR)

- A. Engine Instrument Panel and Safety Switches.
 - 1. Engine Instrument Panel: Provide a generator-mounted instrument panel with gauges for items in the following table.
 - 2. Safety Switches: Provide devices for indication and control of the items in the following table requiring pre-alarm and shutdown.
- B. General: Generator control panel shall include the following equipment;
 - 1. Voltmeter, 1 percent accuracy with 3 phase fuse protection digital type to read true rms.
 - 2. Ammeter, 1 percent accuracy, digital type to read true rms.
 - 3. Frequency meter, 1 percent digital type.
 - 4. Running time meter.
 - 5. Instrument transformers.
 - 6. Automatic starting controls, cycle crank.
 - 7. Voltage level adjustment rheostat, minus 25 to plus 10 percent.
 - 8. Dry contacts for remote alarms wired to terminal strips.
 - 9. Fault indicator lights with press to test feature for low oil pressure, high coolant temperature, low coolant level, overspeed, and overcrank.
 - 10. Visual alarm indicators for impending shutdown from oil pressure and high coolant temperature.
 - 11. Visual alarm indicators for low fuel level and low coolant temperature.
 - 12. Three-position function switch marked "manual", "off/reset", and "auto".
 - 13. Emergency engine stop pushbutton.
 - 14. Panel illumination lights and switch.
- C. Components: Pilot lights and pushbuttons shall be standard duty type.
- D. Devices: Provide relays and timing devices with clear polycarbonate dust covers. Devices shall be plug-in type with holddown spring retainers. Output contacts shall be rated 10 amperes at 24 volt dc.
- E. Controls: Provide engraved or etched nameplates to show position of switches and function of pilot lights, pushbuttons, and meters.
- F. Provide fully automatic load shed controls in the generator control panel. Controls shall automatically disconnect (shed) any block loads designated as non-essential (ATS-N) when the generator load reaches 95% of rated capacity.
- G. Provide fully automatic set start-stop controls in the generator control panel. Controls shall operate as follows;
 - 1. With switch in automatic position closure of a set of external contacts or switch in manual position, the engine shall automatically crank.
 - 2. An adjustable cranking limiter shall allow from 2 to 5 cycles of 30 seconds continuous cranking. If the engine fails to start, starting circuit shall be locked out and the overcrank light illuminated.
 - 3. The engine will shut down when operating in the automatic mode and the remote engine run contact open.

- 4. Initiation of any safety shutdown shall immediately stop the engine and light the appropriate light.
- 5. Upon correction of the fault, the shutoff system shall be made operable by moving the function switch to off/reset and then back to the "auto" position.

2.14 ENGINE MOUNTED GENERATOR MAIN BREAKER

- A. Provide a main line circuit breaker sized in accordance with the NEC per the one-line diagram. Circuit breaker shall be solid station with adjustable settings for long-time pick-up and delay, short-time pick-up and delay, instantaneous. Ground fault functions shall be for annunciation only and shall not trip the circuit breaker.
- B. Circuit breaker shall be trip free of the handle.
- C. The handle position, or a luminescent flag, shall indicate "off", "on", or "tripped" breaker positions.
- D. The trip unit for each pole shall have elements providing inverse time delay during overload conditions and instantaneous magnetic tripping for short-circuit protection. Breaker shall also include a 24 volt D.C. shunt trip for remote trip.
- E. Insulated neutral terminals and a ground terminal shall be provided and marked.
- F. The circuit breaker shall meet standards established by UL, NEMA, and NEC.
- G. Do not use generator exciter field circuit breakers.
- H. Design Selection: Square "D" type LD with 3.3 trip unit.
- **2.15** SOUND ATTENUATED, WEATHERPROOF ENCLOSURE (NON WALK-IN)
 - A. General: The weatherproof enclosure shall be formed steel construction with removable sound attenuated panels. The design and construction shall be modular in that the side panels, doors, and louvers shall not exceed 36-inch in width and shall be a minimum thickness of 14 gauge for all component parts. The roof of the enclosure shall meet or exceed the minimum gauge requirements specified but, in addition, shall be strengthened in such a manner as to support the largest commercially available critical exhaust silencer recommended by the engine manufacturer for this application.
 - B. Attenuation Requirements: The minimum sound attenuation requirements for exterior enclosure with engine generator at full load shall be as follows:
 - 1. 91.9dBA at 3ft from source
 - 2. 82.4dBA at 22ft from source
 - 3. 76.0dBA at 48ft from source
 - C. Metal Treatment: All sheet metal used in the construction of the enclosure shall be electrostatically applied zinc coated.
 - D. Doors: All doors on the enclosure shall be located in areas as to allow ease of maintenance on the generator set and allow access to and visibility of instruments, controls, engine gauges, etc. The doors shall be fitted with bolt-on, stainless steel hinges. Each door shall be fitted with flushmounted, adjustable, same key-lock latches.

- E. Louvers: All louvers shall be designed to prevent the entrance of rainwater, but shall have sufficient free area to allow for 120% of the total engine-generator cooling air requirements used in this application.
- F. Bolts: All components of the enclosure shall be assembled utilizing stainless steel bolts, nuts and lock washers. In addition, watertight neoprene flat washers shall be used on all roof bolts.
- G. Exhaust Connection: Provide mounting brackets for the critical exhaust silencer specified. Provide a 90 degree elbow and rain cap to prevent the entrance of rainwater shall also be supplied. Further, a stainless steel, seamless, flexible exhaust tube and all necessary bolts, flanges, and gaskets to mate with the engine and the critical exhaust silencer shall be provided. The length of the flexible tubing shall be such that additional solid metal nipples or sections shall not be required to be provided as spacers between engine exhaust or the exhaust silencer.
- H. Rain Skirt: Provide "rain skirt" and collar to prevent the entrance of rain and allow for expansion and vibration of the exhaust piping without chafing or stress to the exhaust system.
- I. Rust Inhibitor: Prime paint with a minimum of two coats rust inhibitor primer. The final finish painting shall be a minimum of two coats of color selected by Owner.
- J. Future Use: Enclosure design shall permit the future removal of the enclosure, fuel tank and related components to allow for the engine to be relocated to an interior location.
- 2.16 FUEL PIPING AND STORAGE TANKS
 - A. Tank: Above ground skid mounted fuel storage shall be provided under this section. All fuel oil piping, remote fuel level gauges, and all necessary valves and fittings shall be provided and installed complete as required. The tank shall be a double wall, above-ground sub-base mounted with a minimum capacity of 2,000 gallons or 96 hours at generator 100% load operation, whichever is greater. The Contractor shall be responsible for a complete fuel system installation.
 - B. Coordination: It shall be the responsibility, however, of the generator set supplier to coordinate all materials and work of other trades so that the total installation is complete and fully operational and meets all engine manufacturers' requirements. Any materials or installation required for proper interfacing of all trades shall be provided and installed by the generator set supplier.
 - C. Fuel Filter: Fuel system shall be equipped with replaceable fuel filter elements which may be easily removed without breaking any fuel line connections or disturbing the fuel pump or any other parts of the engine.

2.17 TORSIONAL VIBRATION ANALYSIS

- A. General: Submit a torsional vibration analysis of the engine-generator combination, showing it free of harmful torsional vibration stresses within plus or minus 10 percent of its normal operating speed range, the natural frequency, critical speeds, relative amplitudes of angular displacement, and approximate nodal locations of the complete elastic system of the engine and driven equipment.
- 2.18 REMOTE EMERGENCY STOP STATION
 - A. General: Provide generator stop pushbutton at remote location as indicated on drawings. Pushbutton shall be "push to stop" and "pull to reset". Pull to reset shall not automatically restart generator.

- B. Mounting: Pushbutton shall be installed in flush mounted backbox, 48" centerline above finished floor or grade. Pushbutton shall be provided with a "break glass" or similar type of enclosure to prevent accidental actuation of pushbutton. Device shall be UL listed for wet locations.
- C. Identification: Provide phenolic nameplate in accordance with Section 16030, to read "Generator Emergency Shutdown; Push to Stop; Pull to Reset Station".

2.19 GENERATOR RUN SIGNAL CONTROL WIRE MONITORING

- A. Control wiring for generator run signaling between each Automatic Transfer Switch and Generator shall be monitored for integrity. In the event of any loss of continuity in this wiring, an audible and visual signal shall be annunciated on the Generator Remote Annunciator Panel.
 - 1. At each automatic transfer switch, provide an ASCO engine start module 5101-ATS. This module shall be provided and installed by ASCO.
 - 2. At each generator, provide an ASCO engine start module 5101-GEN. This module shall be supplied by ASCO and installed by engine generator set supplier.
 - 3. At the parallel switchgear, provide one (1) module 5101-ATS per generator and provide one module (1) 5101-GEN per automatic transfer switch.
- B. Generator Run Signal control wiring shall be installed in a separate conduit and not run with any other wiring. Any loss of control wiring integrity shall automatically start the generators per NEC Article 700.

PART 3 - EXECUTION

3.1 GENERAL

- A. Miscellaneous Requirements: Provide the following:
 - 1. Equipment nameplate.
 - 2. Operating manual.
 - 3. Parts list.
 - 4. Special tools (as required).
 - 5. Lubricants.
 - 6. As-built shop drawings.
 - 7. Services of a Manufacturer's Representative, minimum ten (10) days.

3.2 PREVENTIVE MAINTENANCE PROGRAM REQUIREMENT

A. General: The manufacturer of the Power Generation System equipment shall develop a computerized preventative maintenance program. Specific recommendations for actual equipment application shall be made for a computerized program based on operating hours and/or elapsed time. The preventative maintenance recommendations shall be submitted with the shop drawings.

3.3 SYSTEM SERVICE CONTRACT

A. General: The supplier of the power system shall provide a copy of and make available to the Owner his standard service contract which, at the Owner's option, may be accepted or refused. This contract shall accompany any documents, drawings, catalog cuts, specification sheet, wiring or outline drawings, etc. submitted for acceptance to the designing engineer.

3.4 REMOTE ANNUNCIATION

A. General: All necessary relays and wiring shall be provided by the generator system supplier for remote annunciation for each generator of all required alarm and/or control functions.

3.5 FACTORY TESTING

- A. General: Perform factory tests prior to shipment. Include the following;
 - 1. Demonstrate proper operation of all safety devices.
 - 2. Conduct load tests utilizing combination resistive and reactive load banks at generator rated power factor as follows:

Load	Hours
half	1
three quarter	1
full	4

- 3. At the end of two hours at full load, the engine-generator shall be block loaded from no load to full load for a total of two times, and the voltage dip shall be recorded by a strip chart recorder.
- 4. Record current, voltage, frequency, water temperature, lube oil pressure, and lube oil temperature every 15 minutes.
- 5. Submit test reports to the Engineer for review.

3.6 FUEL

- A. General: Division 26 contractor shall be responsible for filling the main tank and day tank with No. 2 fuel oil meeting ASTM D 396. After field testing is complete, refill the tank. Substantial completion shall require all tanks filled to capacity.
- **3.7** PAINTING AND COATING
 - A. Finish: Coat enclosure and structural steel base per specified in other sections. Color of finish coats shall be selected by Owner.

3.8 STARTUP

- A. Initial: On completion of the installation, the initial startup shall be performed by a factory-trained service representative of the engine supplier, who shall thoroughly inspect, operate, test and adjust the equipment.
- B. Provisions: The inspection shall include the soundness of all parts, completeness of all details, proper operation of all components with special emphasis on safety devices, correctness of settings, proper alignments, and correct phase rotation to match other sources.
- C. Tests: Field tests shall include the following;
 - 1. Simulate power failure by tripping the main breaker and demonstrate complete manual and automatic start, load, unload, and stop sequence of the engine-generator.

- 2. Conduct a two-hour run with generator operating, utilizing maximum available load. If available load is less than 100% of the generator's rating, then furnish and add loads to obtain 100% generator loading. Load banks shall be resistive load type.
- 3. Conduct a block loading test in accordance with NFPA-110.

3.9 SCHEDULED OIL SAMPLING

- A. Sampling Analysis: In order to minimize engine failure, the supplier of the equipment shall provide a quarterly (every three months) oil sampling analysis (for each engine) for a period of two years from date of acceptance.
- B. Method: This scheduled oil sampling shall be of the atomic absorption spectrophotometry method accurate to within "1 ppm for the following elements: lead, iron, chromium, copper, aluminum, and silicon.
- C. Test Requirements: In addition, test the sample for the presence of water, fuel, dilution, and antifreeze.
- D. Equipment: Provide equipment needed to take oil samples in a kit at the time of acceptance. Include a sample gun kit, bottles, mailers, and written instructions.
- E. Notification: Provide immediate notification (within two hours of analysis) by telephone or fax to the Owner when analysis results show any critical reading. If readings are normal, provide a report by mail showing that the equipment is operating within established requirements.
- F. Owner Availability: This scheduled oil sampling program to be available to the Owner at the supplier's normal rate, after the mandatory 2 years and shall be continued thereafter at the Owner's option.

3.10 ENGINE GENERATOR TEST PROCEDURE

- A. General Overview: The test shall be performed in accordance with the latest edition of the NFPA-110, and as modified herein. Two basic load tests shall be performed after the EPSS is completely installed. The first test shall utilize the maximum available building load and the second test shall utilize a full capacity load bank. As indicated by the specifications, as pre AHCA test, conforming completely to this procedure will be conducted prior to the test which is to be witnessed by AHCA. All test procedures will be documented and submitted to AHCA for approval.
- B. Procedure: Provide an outline of the entire test procedure to be followed. The outline shall include the following:
 - 1. Breaker and relay positions (open or closed) prior to loss of power.
 - 2. Method of initiating power loss.
 - 3. Locations of observation points during the tests to properly record all necessary data and observe operating conditions. A plan showing these locations may be necessary for a complicated or "spread-out" type system. The time required to restore each type of priority load shall be recorded and any changes in breaker relay position must be noted.
 - 4. Procedure to perform the cycle crank test for each engine.

- 5. Procedure to test all safety alarms, pre-alarms, shutdown requirements and annunciation including a diagram showing where safety monitoring devices are located and how each will be activated.
- 6. Other procedures necessary for a complete test.
- C. Test Requirements: The following are requirements for testing;
 - 1. With prime mover in a "cold start" condition and emergency load at normal operating level, initiate a normal power failure to the building or facility. Test load shall be the maximum load that is served by the EPSS.
 - a. Observe and record the time delay on start for each generator.
 - b. Observe and record the cranking time until each prime mover starts and runs.
 - c. Observe and record the time required to reach operating speed.
 - d. Record voltage and frequency overshoot for each generator. Utilize appropriately sensitive meters.
 - e. Record time that each generator closes to the parallel bus, where applicable.
 - f. Observe and record time required to achieve steady-state condition with all switches transferred to the emergency position. Verify that each transfer switch has properly transferred.
 - g. Record voltage, frequency, and amperes for each generator and for the parallel bus. Record the data at first load acceptance and every 15 minutes thereafter until the completion of the two-hour test period.
 - h. Record prime mover oil pressure, water temperature where applicable, and battery charge rate at 5 minute intervals for the first 15 minutes, and at 15 minute intervals thereafter.
 - i. Continue load test for two hours observing and recording load changes and the resultant effect on voltage and frequency.
 - j. Verify that all loads have transferred and are operating as follows:
 - Look for motor starters that are locked out and do not automatically restart.
 - Check to see that elevators are re-energized within 60 seconds.
 - Verify that smoke evacuation fans, smoke removal fans and fire pump and pressurization fans are energized by testing the fire alarm and sprinkler systems as necessary to operate these systems while the generator system is running.
 - Verify that duct dampers associated with emergency AHU's and exhaust fans are open.
 - Verify that no exhaust gases are entering hospital. Disconnect the largest generator unit and observe and record loads disconnected.
 - Compare with expected results and priority scheme.
 - Verify that all essential system loads are still energized and status of all circuit breakers.
 - k. Return normal power to the building or facility, record the time delay on retransfer to normal for each switch (minimum setting: 30 minutes), and the time delay on prime mover cool down period and shutdown (minimum setting: 5 min.).
 - 2. After completion of the above test, the prime movers shall be allowed to cool for 5 minutes, after which the following full load test shall be performed;
 - a. Full Load Test: A load shall be applied for a two-hour, full load test. The building load can serve as part or all of the load, supplemented by a load bank of sufficient

size to provide a load equal to 100 percent of the nameplate KVA rating (at unity power factor) of the EPS, less applicable derating site conditions.

- b. The full load test shall be initiated immediately after the cooling time allowed above by any method that will start the prime mover and, immediately upon reaching rated rpm, pick up 100 percent of nameplate KW rating on one step, less applicable derating factors for site conditions. Record instantaneous and sustained voltage dips for all load applications and compare to manufacturer's criteria. Record prime mover data same as in item 1.h. above. Where parallel systems are designed to pick up blocks of load, as each generator connects to the parallel bus, the block load application shall simulate this procedure and each block of load will equal the generator rating.
- c. At the end of the two-hour period, test the complete operation of the "loss of generator, load shed controls" by disconnecting one generator at a time and observing/recording load shed results. Then reconnect the generators one at a time and observe, record load re-add results.
- d. Reconnect normal power. Record final breaker and relay positions.
- e. Disconnect load bank and reconnect building loads.
- f. Allow generators to run through their cool down cycle and shutoff. Record cool down cycle time.
- g. Tabulate all data and submit a complete testing report to the Engineer. Report is to include all results compared to expected or published maximums, minimums or normal operation.
- 3. Cycle Crank Test: Utilize any method recommended by the manufacturer to prevent the prime mover from running. Put the control switch into "run" to cause the prime mover to crank. Observe the complete crank/test cycle as follows:

A complete cranking cycle shall consist of an automatic crank period of approximately 15 seconds duration followed by a rest period of approximately 15 seconds duration. Upon starting and running of the prime mover, further cranking shall cease. Two means of cranking termination shall be utilized so that one will act as backup to the other to prevent inadvertent starter engagement. Fifteen KW and smaller otto cycle and all diesel prime movers shall be permitted to use continuous cranking methods. Cranking limiter time shall be 75 seconds for cycle crank and 45 seconds for continuous crank.

- 4. Test all safeties specified in NFPA 110, Section 3-5.5 and 3-5.6 as recommended by the manufacturer and as required to verify proper operation.
- 5. The following shall be made available to the Engineer at the time of the acceptance test: a. Results of the prototype test required by NFPA 110, Section 3-2.1
 - b. Certified analysis required in NFPA 110, Section 3-5.10.2 (Torsional Vibration Compatibility Test).
 - c. Results of complete generator damage and decrement curves.
 - d. A manufacturer's certification of a rated-load test at rated power factor with the ambient, altitude, and fuel grade recorded.
 - e. Generator parameters, expected circulating currents and harmonic generation analysis, including recommended derating.
- 6. Provide the following independent acceptance test for engine generators in accordance with International Electrical Testing Association specification:

- a. Insulation resistance tests on generator winding with respect to ground in accordance with ANSI/IEEE Standard 43. Determine polarization index.
- b. Test protective relay devices in accordance with applicable sections of NETA ATS.
- c. Perform phase rotation test to determine compatibility with load requirements.
- d. Where unusual vibration or noise occurs, perform vibration base-line test. Plot amplitude versus frequency for each main bearing cap.
- e. Test values shall be as follows:
- 7. Insulation-resistance test shall be at voltage listed in Table 10.2 of NETA ATS-1991.
- 8. Polarization index values shall be in accordance with IEEE Standard 43.
- 9. Vibration levels shall not exceed manufacturer's published recommendations.

END OF SECTION 263213

SECTION 26 3600 AUTOMATIC TRANSFER SWITCH (UP TO 600V)

PART1- GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 DESCRIPTION

- A. General: Provide automatic transfer switches of the size, number of poles, amperage, voltage and withstand ratings as shown on the contract drawings and as specified herein.
- B. Description: Using a NEMA 1 enclosure, the switches shall automatically transfer the load to the generator during normal power outages. The switches shall be fully rated, electrically operated, mechanically held unit with both electrical and mechanical interlocks to prevent simultaneous energizing of both sides.
- C. Bypass: The switch shall have a manual bypass isolation operating handle with transfer speed equal to automatic operation. The manual operating handle shall be dead front. Provide bypass isolation feature for all transfer switches.

1.3 QUALITY ASSURANCE

- A. Manufacturer Requirements: Firms regularly engaged in manufacture of automatic transfer switches, of types and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Manufacturers: Subject to compliance with the requirements of this specification, provide an automatic transfer switch manufactured by the following (no substitutions):

Manufacturer	<u>Model No.</u>
ASCO	7000 Series - No Substitutions

- C. Standards: Comply With The Following Standards:
 - 1. UL-1008, 7th Edition.
 - 2. As a precondition for acceptance, transfer switch, complete with timers relays and accessories shall be listed by Underwriters Laboratories, Inc. in their Electrical Construction Materials Catalog, and accepted for use on emergency systems.
 - 3. When conducting temperature rise tests per UL-1008 the manufacturer shall include post-endurance temperature rise tests to verify the ability of the transfer switch to carry full rated current after completing the overload and endurance tests.
 - 4. Produce UL 1008 closing and withstand ratings for 0.05 seconds at the ATS's rated voltage certified test reports from an independent testing laboratory to verify the identical samples have been subject to three phase short circuit current at voltage indicated on drawings, for a minimum of 0.05 seconds duration, without contact

damage or contact welding and without the use of current limiting fuse protection. ATS shall be provided with required withstand rating regardless of upstream overcurrent device. Oscillograph traces are to be supplied to verify that the test parameters have been met. The above shall be met with any overcurrent device upstream. ATS used with upstream breakers provided with Short Time Response shall have a Short Time Rating per UL 1008 7th Edition.

1.4 SUBMITTALS

- A. Shop Drawings: Provide all equipment cabinet dimensions and wiring diagrams as required.
- B. Product Data: Provide all applicable options, accessories, and interrupting or withstanding current ratings. Provide all electrical characteristics and data as required to show compliance with these specifications.
- C. Testing: Provide test results from UL 1008 as listed above. Provide actual nameplate data to be provided inside switch enclosure for review.

1.5 PRODUCT HANDLING

- A. Equipment Storage: The Contractor shall store items provided under these specifications until time of installation. Such storage shall meet the requirements of the system supplier and be accepted by the Engineer. The stored equipment shall not be delivered to the site until it is to be installed.
- B. Protection: Use all means necessary to protect the materials of this section before, during and after installation and to protect the installed work and materials from the activities of all other trades.
- C. Replacement: In the event of damage, immediately make all repairs and replacements necessary to the acceptance of the Engineer and at no cost to the Owner.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Type: Provide 3-pole or 4-pole automatic transfer switches as indicated on plans, with full load current and voltage rating as shown, 60 Hz normal and emergency.
- B. Load Types: The transfer switch shall be capable of switching all classes of load, and shall be rated for continuous duty when installed in a non-ventilated enclosure that is constructed in accordance with Underwriters Laboratories, Inc., Standard UL-1008.
- C. Accessories: All relays, timers, control wiring and accessories to be front accessible.
- D. Housing: All transfer switches shall be floor-standing enclosures with front and either side or rear accessibility.

2.2 COMPONENTS

A. Features: Provide the following transfer switch features;

- 1. The transfer switch shall be double throw, actuated by a single electrical operator momentarily energized; and mechanically connected to the transfer mechanism by a simple over center type linkage with a total transfer time not to exceed 1/6 of a second.
- 2. The mechanism shall be a high speed actuator, capable of transferring successfully in either direction with 70 percent of rated voltage applied to the switch terminals.
- 3. Circuit breaker switches are not acceptable.
- 4. Mechanical interlocking of transfer switches to prevent unintended interconnection of the normal and alternate sources of power.
- 5. A means of safe manual operation of the transfer switch.
- B. Main Contacts: The normal and emergency contacts shall be positively interlocked mechanically and electrically to prevent simultaneous closing. Main contacts shall be fully rated, arc quenching, mechanically locked in both the normal and emergency positions without the use of hooks, latches, magnet, or springs and shall be renewable silver-tungsten alloy protected by arcing contacts, with magnetic blowouts on each pole. Contacts shall be able to withstand high fault current levels without contact damage or separation. Parallel main contacts are not acceptable.
- C. Exercise Timer: Include an exerciser with the transfer switches for exercising the generator in loaded or unloaded condition, up to every 168 hours for a period adjustable from a minimum of 20 minute intervals to 24 hours.
- D. Delayed Transition: Provide off-time (center-off or neutral position) capability with controls for transfer and retransfer of motor and inductive loads so that inrush currents do not exceed normal starting currents. All equipment branch and non-essential branch transfer switches shall be delayed transition.
- E. Neutral Contacts: Include fourth pole neutral contacts with same rating as power poles.
- F. Engine Start Delay: Time delay to override momentary normal source power outages to delay engine start signal and transfer switch operation. Adjustable 0.5 to 3 seconds, factory set at 3 seconds.
- G. Load Test Switch: Load test switch to simulate normal power failure. (Maintained type). Provide dry contacts on Test switch to interface with Powerlogics I/O Card
- H. Contact Failure Indicators: Contact to open on failure of normal and emergency sources to interface with PM8000 meter.
- I. Pilot lights: Green push to test pilot light on the cabinet door to indicate the main switch in normal position. Red push to test pilot light on the cabinet door to indicate the main switch in emergency position.
 - 1. "Normal Source Available" Green Pilot Light
 - 2. "Emergency Source Available" Red Pilot Light
- J. Auxiliary Contacts: Provide an auxiliary contact closed in normal position. Provide an auxiliary contact closed in emergency position. Include bypass position contacts (open/closed, test, automatic, isolate)

K. A transfer inhibit function shall be provided to prevent designated switches from transferring to the emergency position until sufficient generating capacity is available.

Automatic transfer switches with this feature shall be prevented from transferring to the emergency position until the generator control system initiates a contact closure for the transfer inhibit circuit. The transfer inhibit circuit shall be wired as fail safe such that an open circuit will prevent the automatic transfer switch from transferring to the emergency position. Provide this feature on designated switches (all equipment branch and non-essential branch) as indicated on the drawings. Coordinate requirements with the generator control switchgear supplier.

- L. A load shed function shall be provided for designated automatic transfer switches as indicated on the drawings to disconnect the load from the emergency source when an overload condition occurs. The load shed feature is activated by the opening of a contact at the generator control panel. The load shed circuit shall be wired as "fail safe" such that an open circuit shall activate the load shed function at the automatic transfer switch. Coordinate requirements with the generator supplier.
 - 1. Automatic transfer switches that are equipped with the load shed feature shall have an "Off" position. If the load shed function is activated, the switch shall transfer to the "Off" position in lieu of the normal position.
 - 2. All equipment branch and non-essential branch transfer switches shall be equipped with the load shed feature. Life safety and critical branch transfer switches shall not be provided with load shed feature.
- M. Additional Contacts: Two sets of relay contacts shall be provided to open and close upon loss of the normal power supply.
- N. Display: Provide LCD display to indicate system status, and voltage. Display shall also be used for programming of time delays.
- O. Network communications module for remote monitoring and control of ATS. Data shall be transmitted from each automatic transfer switch back to master controller located in the engineering building. Data shall be transmitted over (Category 5e unshielded twisted per cable) within the building. The following items shall be monitored and controlled as a minimum:
 - 1. Emergency / Normal Source Data: Voltage, current, frequency, power factor, total KW, total KVAR, total KVA, source available, source connected, under/over voltage failure, loss of phase failure, under/over frequency failure and phase rotation failure.
 - 2. Load: Voltage, current, frequency, power factor, total KW, total KVAR and total KVA.
 - 3. Status: Switch position (normal or emergency), exercise in progress, common alarm, time delay status, ATS test in progress, transfer pending, load shed status, transfer inhibit status, network battery low.
 - 4. Connect to Square "D" Power Logic network via factory installed Square "D" Powerlogic PM8000 meter.
 - 5. Refer to specification section 26 0913 for further requirements.
- P. All automatic transfer switches shall include Square D's Powerlogic Metering (PM8000 meter) integral to the ATS. This shall be factory installed.

2.3 BYPASS AND ISOLATION SWITCHING

- A. Isolation and Bypass Switch: Make before make bypass of the load to either the normal or the emergency power source and complete isolation of the automatic transfer switch. Provide automatic transfer and bypass-isolation switches as a product of one manufacturer and be completely factory interconnected and tested as a unit.
- B. Operation: The bypass-isolation switch shall permit proper operations by one person through the movement of two handles at a common dead front panel.
- C. Ratings: The electrical ratings of the bypass-isolation switch shall equal or exceed those of the associated automatic transfer switch.
- D. Bussing: All interconnection between transfer and bypass switches are by silver plated copper bus bar.
- E. Indication: Provide a visual position indicator showing switch position, and availability of normal and emergency sources.

2.4 OPERATION

- A. Low Voltage: Provide normally open (closed to start) engine starting contacts in transfer switches to start engine generators if any ungrounded phase of the normal source drops below 70 percent of rated voltage, after a non-adjustable time delay period of 1 to 3 seconds, to allow for momentary dips.
 - 1. Generator start signals shall be "open to start", to provide additional troubleshooting capabilities in the event of a start circuit failure.
- B. Transfer: The transfer switch shall transfer to emergency as soon as the generator source voltage and frequency have reached 90 percent of rated values.
- C. Stabilization; After restoration of normal power on all phases to 90 to 95 percent of rated voltage, adjustable time delay period of 2 to 25 minutes shall delay transfer to normal power until it has had time to stabilize. If the emergency power source shall fail during the time delay period, the time delay shall be by-passed, and the switch shall return immediately to the normal source.
- D. Generator No-Load Operation: Whenever the switch has retransferred to normal, the engine-generator shall be allowed to operate at no load for a fixed period of time (5 minutes) to allow it to cool before shut-down.
- E. Test Switch: The transfer switch shall include a test switch to simulate normal power failure with actual load transfer.

2.5 GENERATOR RUN SIGNAL CONTROL WIRING MONITORING

A. Control wiring for generator run signaling between each Automatic Transfer Switch Aand Generator shall be monitored for integrity. In the event of any loss of continuity in this wiring, an audible and visual signal shall be annunciated on the Generator Remote Annunciator Panel.

- 1. At each automatic transfer switch, provide an ASCO engine start module 5101-ATS. This module shall be provided and installed by ASCO.
- 2. At each generator, provide an ASCO engine start module 5101-GEN. This module shall be supplied by ASCO and installed by engine generator set supplier.
- 3. At the parallel switchgear, provide one (1) module 5101-ATS per generator and provide one module (1) 5101-GEN per automatic transfer switch.
- B. Generator Run Signal control wiring shall be installed in a separate conduit and not run with any other wiring. Any loss of control wiring integrity shall automatically start the generators per NEC Article 700.

PART 3 - EXECUTION

3.1 INSTALLATION CONDITIONS

- A. Inspection: Prior to performing the work required by this section, carefully inspect the installed materials and equipment of all other trades and verify that the project has progressed to a point where this inspection may properly begin.
- B. Verification: Verify that all equipment provided under this section of the specification may be installed in accordance with all pertinent codes and regulations, the original design, and the referenced standards.
- C. Discrepancies: If any discrepancies are found, immediately notify the Engineer. Do not proceed with the installation in areas of discrepancy until all such discrepancies have been fully resolved.
- D. Pads: Provide 4 inch concrete housekeeping pad for all floor mounted transfer switches, unless specifically indicated otherwise by manufacturer's recommendations.

3.2 CONNECTIONS

A. Tightening Connectors: Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torqueing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Stds. 486A and 486B.

3.3 WARRANTY

- A. Duration: Provide a 5 year comprehensive warranty for all parts and labor for each transfer switch.
- B. Submittal: Provide warranty information as part of shop drawing submittal and Operations and Maintenance manuals.

END OF SECTION 26 3600

SECTION 26 4113 LIGHTNING PROTECTION SYSTEM

PART1- GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work specified of this section.

1.2 DESCRIPTION

- A. General: Provide a complete lightning protection system as indicated on the drawings and as specified herein. The lightning protection system shall be installed by a firm presently engaged in installations of Master Labeled or LPI certified lightning protection systems. The system as completed shall comply with the latest edition of UL96A, Installation Requirements for Lightning Protection Systems, and NFPA-780 "Standard for the Installation of Lightning Protection Systems." The system shall meet all requirements of these standards and the Lightning Protection Institute Standard of Practice LPI-175. All components required for a UL master label and a full LPI certification plate shall be provided whether or not such materials are specifically addressed by the contract drawings or described herein.
- B. Qualification: All installers shall be experienced with installing UL master labeled and LPI certified systems or of equivalent qualification, as accepted in writing by the engineer of record. A UL/LPI certified installer shall be on the project site at all times during installation of the systems and shall supervise all of the installation.

1.3 COUNTERPOISE CONDUCTOR

- A. General: The structure shall be provided with a below-grade continuous counterpoise conductor, equal in size to the largest conductor in the building lightning protection system, or sized as indicated on the drawing. This conductor shall be installed at a minimum depth of two feet below finished grade and a minimum of two feet from the exterior foundation wall of the building. The counterpoise conductor shall be copper and extend continuously around the entire perimeter of the building. All joints and connections shall be exothermically welded.
- B. Counterpoise: As a minimum, the counterpoise conductor shall be connected to each of the following system components utilizing appropriate exothermic welds:
 - 1. Each down conductor.
 - 2. All counterpoise conductors on power and communications ducts which enter the building.
 - 3. The building electrical service ground.
 - 4. All metallic water and gas services entering the building (ahead of meter).
 - 5. All metallic fence posts, safety railings, etc., or any other metallic item within ten feet of the project building.

1.4 SUBMITTALS

- A. General: Shop drawings identifying all system wiring and component placement, including all details, shall be submitted to the Engineer for review. The Contractor shall not perform any portion of the Work until the respective submittal has been accepted. All work shall be in accordance with accepted submittals.
- B. Detail Submission: Details shall be submitted to the Engineer for review indicating the method of cabling connections and attachments starting at the top of the project building to the ground rods at the counterpoise. All details shall be appropriate for the project.
- C. Identification: All product data sheets submitted, for proposed system components, shall clearly identify the item being submitted and shall indicate the UL label.
- D. Suppression Device: All transient voltage surge suppressors for the project shall be submitted at the same time as the lightning protection floor plans, details and product data sheets are submitted. Each suppressor shall clearly indicate the item to be protected and shall comply with Section 26 4313 of these specifications. Suppressors shall be provided as required in NFPA 780 unless otherwise indicated on the drawings or otherwise specified.
- E. Deviations: The Contractor shall not be relieved of responsibility for deviations from requirements of the Contract Documents by the acceptance of shop drawings, product data, samples or similar submittals unless the Contractor has specifically informed the Engineer in writing of such deviation at the time of submittal and the Engineer has given written acceptance to the specific deviation.
- F. Certification: Provide documentation of UL master label, LPI certification or equivalent qualification of exact installer intended to do this particular job.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Labels: All materials used for the system installation shall comply in size, composition and weight to all requirements of NFPA U.L. and LPI for the class of system in which they are installed. All materials shall be labeled or listed by Underwriters Laboratories, Inc. for use in master labeled or LPI certified lightning protection systems.
- B. Material: Generally, the external lightning protection system at the roof level shall be constructed of aluminum cable and aluminum compatible components. The internal lightning protection system, starting with the down conductors and concluding at the ground termination system (counterpoise and dissipation points) shall be constructed of copper cable and copper compatible components. Likewise, all bonding conductors, equipotential loop conductors, etc, shall also be constructed of compatible cable and components.
- C. Compatibility: All portions of the system, whether copper or aluminum, shall be galvanically compatible to the building material to which they are to be attached. Connections between copper and aluminum portions of the system shall be made with appropriate bimetallic coupling devices. In all areas, the conductor shall be supported to maintain clearance from all galvanically incompatible materials or shall be of the same material if permitted within these specifications.

D. Components: All system components (i.e. air terminals, bases, connectors, cable, thruroof fittings, ground rods, etc.) shall be, to the maximum extent possible, the product of a single manufacturer. All components shall be Class I or II as required by NFPA 780 or as noted. All air terminal bases shall be securely mounted to the building structure by means of adhesive or fasteners. Adhesive type air terminal bases are acceptable only where hard setting epoxy adhesive is utilized, where mechanical fastening is prohibited by the roofing manufacturer and where acceptable to the code authority having jurisdiction. Submit shop drawings for all proposed air terminal mounting details.

2.2 AIR TERMINALS

- A. General: Air Terminals shall be solid aluminum as required to match the building system to which they attach. Air terminals shall protrude a minimum of 10 inches above the object to be protected. Center roof terminals shall be 24" high. Air terminal points shall be blunt with the radius of curvature equal to the rod diameter.
- B. Base: Each air terminal shall be equipped with the correct type of base for the location in which it is mounted.
- C. Roof Top Equipment: Air terminals and interconnecting cable shall be provided for all roof mounted equipment (fans, A/C equipment, etc.) subject to a direct strike as required by NFPA 780 and as shown. Unless specifically noted, use of equipment housing in lieu of interconnecting cables is strictly prohibited. Provide sufficient length at all equipment mounted terminals to allow removal of the terminal without requiring removal/disconnect of the conductor.

2.3 CONDUCTORS

- A. General: Main roof conductors shall be aluminum unless otherwise specified or required and shall provide a two-way path from each air terminal horizontally or downward to connections with down conductors. Conductors shall be free of excessive splices and bends. No bend of a conductor shall form an included angle of less than 90 degrees nor have a radius of bend of less than 8 inches. Conductors shall be secured to the structure at intervals not exceeding 3 feet with approved fasteners. Cables connected to "thru-roof" connectors may rise from the roof to the connector at a maximum slope of 3 inches per foot, not exceeding 3 feet horizontally in air.
- B. Down Conductors: Down conductors shall be copper and shall be concealed in the exterior wall construction or structural columns. Where run in or on reinforced concrete columns, bond down conductor to the re-bar at top and bottom of column. Where "bottom of column" occurs below the installed counterpoise elevation (-2'-0' BFG), bond to column steel reinforcement at same elevation that down conductor exits column to bond counterpoise conductor. Down conductors shall be spaced at intervals averaging not more than 100 feet around the perimeter of the structure. Connections to the steel frame shall be made with heavy duty bonding plates having 8 square inches of contact surface or with exothermic welds.
- C. Shop Drawing: Submit all conductor types in shop drawings. Each conductor shall be identified as to location in the lightning protection system.

2.4 ROOF PENETRATIONS

A. General: Roof penetrations required for down conductors or for connections to structural steel framework shall be made using pre-manufactured U.L. approved thru-roof type

assemblies with solid rods, PVC sleeves and appropriate roof flashing. Roof flashing shall be compatible with the roofing system and shall be provided under this contract and installed by the roofing contractor. Submit roof flashing data sheets and letter of acceptance from roofing contractor in shop drawing package.

2.5 COMMON GROUNDING

- A. General: Common grounding of all ground mediums within the project building shall be made by interconnecting with main size conductors, fittings as required or exothermic welds.
- B. Bonding: Grounded metal bodies located within the required bonding distance (as determined by the bonding distance formulas in NFPA 780) shall be bonded to the system using bonding conductors and fittings. Bond to rebar utilizing exothermic weld connections.

2.6 GROUND TERMINATIONS

A. General: Two ground terminations shall be provided for each down conductor and shall consist of two 5/8 inch x 10 feet copper-clad ground rods with a 10 to 15 foot separation. Each down conductor shall be connected to the ground rods by an exothermic weld connection. Tops of ground rods shall be located 2 feet below finished grade and 2 feet from the foundation wall and shall extend a minimum of 10 feet vertically into the earth. Where a counterpoise is provided, rods shall be interconnected with the counterpoise.

2.7 FASTENERS

A. General: Conductor fasteners shall be manufactured of a material which is compatible with the type of conductor being supported. Fasteners shall be of sufficient strength to properly support each conductor or terminal base, etc.

2.8 ACCEPTABLE MANUFACTURERS

A. Manufacturers: Equipment manufactured by Thompson Lightning Protection, Inc., Harger Lightning Protection, Independent Lightning Protection or East Coast Lightning Protection shall be considered acceptable.

PART 3 - EXECUTION

3.1 INSTALLATION OF CONDUCTORS

- A. General: Conductors shall be installed to interconnect all air terminals to the system of grounding electrodes, and in general provide a minimum of at least 2 paths to ground from any air terminal on the system. Conductors shall provide a horizontal or downward path between the system air terminals and grounding electrode system.
- B. Routing: Conductors shall be routed in such a manner that maximum concealment from public view is achieved. Down conductors may be installed in one-inch PVC conduit from roof to grade.
- C. Counterpoise Conductors: Counterpoise conductors shall be installed after finished grades are established to insure specified depth and to minimize the possibility of damage. Any counterpoise conductor which is cut or damaged shall be repaired or replaced with no additional cost to the contract.

D. Connections: All connections between conductors below grade shall be exothermically welded. Improper application of weld shall be replaced at no additional cost to the contract.

3.2 INSTALLATION OF GROUND RODS

- A. General: Ground rods shall be installed vertically at each down conductor position at a minimum of 2 feet from the building foundation wall. Inspection and documentation at each grounded location, weld, depth of counterpoise, etc., shall be made prior to backfill. Contractor shall notify engineer in writing to request inspection of underground work and for L.P.I. inspection before backfill. Allow a minimum of one week for engineer to make the inspection after notification from contractor.
- B. Test/Inspection Wells: Provide traffic-rated, prefabricated test and inspection wells for all ground rods installed in paved or concrete areas.

3.3 INSPECTION WELLS

- A. Location: Provide inspection wells for all ground rods covered by concrete, paving, landscape material or other permanent materials that prevent access to ground rods.
- B. Description: Inspection well shall be provided with circular, flush traffic rated, grade mounted, twist lock traffic cover with the word "ground" (or similar) on the cover. Inspection test well shall allow clear access to the ground rod and exothermic weld connection of conductor to ground rod. Clearly mark ground rod locations on as-built drawings.

3.4 BONDING OF SECONDARY METALLIC BODIES

- A. Structure Grounding: Provision shall be made at the roof level on reinforced concrete structures for bonding between the roof or down conductors, metallic elements of the roof system and metallic exterior wall systems.
- B. Bonding: All down conductors run in concrete columns shall be bonded to the reinforcing steel at the top and the bottom of the column.

3.5 GENERAL WORKMANSHIP

- A. General: All elements of the Lightning Protection System shall be installed in a professional and workmanlike manner consistent with the best industry practices.
- B. Concealed Installation: All system components shall be concealed to the maximum extent possible to preserve the aesthetic appearance of the project building on which the system is installed.

3.6 COORDINATION WITH OTHER TRADES

- A. Coordination: The Contractor shall coordinate his work with all trades, to insure the use of proper materials and procedures in and around the roof in order not to jeopardize the roofing warranty.
- B. Fasteners: Where fasteners are to be embedded in masonry or the structural system, they shall be coordinated to insure installation at the proper time of construction.

C. Certification: Upon completion of the installation the Contractor shall provide to the owner the Master Label issued by Underwriters Laboratories, Inc. for the installation, and the LPI certification issued by LPI.

END OF DOCUMENT 26 4113

SECTION 26 4313 TRANSIENT VOLTAGE SURGE SUPPRESSION

PART 1 - GENERAL

1.0 SUMMARY

A. The specifications in this section describe the electrical and mechanical requirements for a protection system provided by high-energy transient voltage surge suppressors. The specified system shall provide effective, high-energy surge current diversion and be suitable for application in ANSI/IEEE C62.41 Category A, B and C environments (as tested by ANSI/IEEE C62).

1.1 STANDARDS

- A. The specified system shall be designed, manufactured, tested and installed in compliance with the following codes and standards:
 - 1. Institute of Electrical and Electronic Engineers (ANSI/IEEE C62.11, C62.41, C62.45)
 - 2. American National Standards Institute
 - 3. Federal Information Processing Standards Publication 94 (FIPS PUB 94)
 - 4. National Electrical Manufacturer Association (prior to repeal NEMA LS-1 1992 Peak Current Testing)
 - 5. National Fire Protection Association (NFPA 70, 75 and 780)
 - 6. MIL Standard 220A Method of Insertion Loss Measurement
 - 7. National Electric Code
 - 8. Underwriters Laboratories UL 1283 and UL 1449 (most recent edition)
 - 9. Canadian Standards (cUL or cETL)

1.2 ENVIRONMENTAL REQUIREMENTS

- A. The operating temperature range shall be -40° to 70° C (-40° to 160° F).
- B. The unit shall be capable of operation up to 13,000 feet above sea level.
- C. No appreciable magnetic fields shall be generated.

1.3 SUBMITTALS

- A. Product Data: Provide catalog sheets showing voltage, physical size, IEEE let through voltage for each waveform listed, UL1449 latest revision, latest edition, suppressed voltage ratings, dimensions showing construction, lifting and support points, enclosure details, per mode and per phase peak surge current, modes of discrete suppression circuitry, warranty period and replacement terms, conductor size, conductor type and lead length.
- B. Submit product data for all components and accessories.
- C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product. Indicate maximum size of circuit breaker or fuse to be connected for each unit.
- D. List and detail all protection systems such as fuses, disconnecting means and protective features.
- E. Provide verification that the TVSS device complies with the required UL1449 latest edition, latest revision, and CSA approvals.

- F. Provide actual let through voltage test data in the form of oscillograph results for the ANSI/IEEE C62.41 Category C3 & C1 (combination wave) and A1 (ringwave) tested in accordance with ANSI/IEEE C62.45.
- G. Provide spectrum analysis of each unit based on MIL-STD-220A test procedures between 10 kHz and 100 kHz verifying the devices noise attenuation equals or exceeds 40 dB at 100 kHz.
- H. For retrofit mounting applications, provide electrical/mechanical drawings showing unit dimensions, weights, installation instruction details, and wiring configuration.
- Provide test report from a recognized independent testing laboratory verifying the suppressor components can survive published surge current rating on a per mode basis using the IEEE C 62.41, 8x20 microsecond current wave. Test data must be on a complete SPD with internal fusing in place. Test data on an individual module is not acceptable.

1.4 QUALITY ASSURANCE AND WARRANTY

- A. The panel mounted SPD and supporting components shall be guaranteed by the manufacturer to be free of defects in material and workmanship for a period of thirty (30) years from the date of substantial completion of service and activation of the system to which the suppressor is attached. Additionally, the warranty shall state that during the applicable warranty period any SPD which fails due to any transient surge activity, including lightning, shall be repaired or replaced by the manufacturer without charge. Special or optional warranties in excess of the unit's standard warranty for purposes of this bid are not acceptable.
- B. Since "Acts of Nature" or similar statements typically include the threat of lightning to which the SPDs shall be exposed, any such clause limiting warranty responsibility in the general conditions of this specification shall not apply to this particular section. That is, the warranty must specifically provide for unlimited free replacements of the SPD in the event of failure caused by the effects of lightning and all other electrical anomalies. The warranty shall cover the entire device, not just various components, such as modules only.
- C. Provide electrically operated equipment specified in this Section that is listed and labeled. As defined in the National Electrical Code, Article 100, Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.
- D. Comply with NFPA 70 and Nema LS1.

1.5 MANUFACTURER QUALIFICATIONS

- A. The SPD's shall be manufactured in the USA by a manufacturer that has been regularly engaged in the design, manufacturing and testing of SPD's of the types and ratings required for a period of not less than five years.
- B. Acceptable manufacturers include Total Protection Solution, Surge Suppression Inc., and PowerLogics.
PART 2 - PRODUCTS

2.1 PERFORMANCE

- A. General:
 - 1. The SPD shall be listed by ETL, UL, or other nationally recognized test laboratory to UL's 1283 and UL's 1449 standards (latest edition, latest revision), and not merely the components or modules. All SPD's shall be Type 1 for use in Type 1 and Type 2 locations.
 - 2. The TVSS shall protect all modes L-G, L-N, L-L, and N-G, for WYE systems have discrete suppression circuitry in L-G, L-N and N-G, and have bidirectional, positive and negative impulse protection. Line-to-neutral-to-ground protection is not acceptable where line-to-ground is specified, and accordingly reduced mode units with suppression circuitry built into only 4 modes are not acceptable. For delta systems, the unit shall have discrete suppression circuitry in L-G and L-L.
 - The maximum continuous operating voltage (MCOV) of all components shall not be less than 125% for a 120V system and 120% for 220 and 240V systems, and 115% for 277 and 480V systems.
 - 4. All SPD's shall be equipped with a comprehensive monitoring system which shall include a visual LCD panel display providing information on unit status and phase loss/protection loss.
 - 5. If a disconnect switch is specified, the disconnect switch and the SPD as a system shall be capable of interrupting up to a 200kA symmetrical fault current with 600 VAC applied.
 - 6. Each design configuration shall have the maximum single pulse surge current capacity per mode verified through testing at an independent, nationally recognized test laboratory. To be considered for approval, the manufacturer must submit a test report on a unit which was tested with internal over current fusing in place. The test shall include a 1.2 X 50 µsec 6000V open circuit voltage waveform and an 8 X 20 µsec 500A short circuit current waveform to benchmark the unit's suppression voltage, followed by a single pulse surge of maximum rated surge current magnitude with an approximated 8 X 20 µsec waveform. To complete the test, another identical surge shall be applied to verify the unit's survival. Compliance is achieved if the suppression voltage found from the two impulses do not vary by more than +10%. Test data on an individual module is not acceptable.
- B. Subpanel and Lighting Panel Protection:
 - 1. SPD(s) for this location shall be as indicated on project drawings. SPD shall be separate from panelboard. Integral SPD shall not be acceptable. SPD's shall be certified to UL1283 and UL1449 Third Ed. Type 1 for use in Type 1 and Type 2 locations.
 - Subpanels and lighting panels shall be protected by a Total Protection Solutions panel mounted SPD, model TK-LP120-3Y277/480-L-F for 277/480 (4W+G) volt panels, TK-LP120-3Y208-L-F for 120/208 (4W+G) volt panels and TK-LP120-1S240-L-F for 120/240 (3W+G) volt split phase panels:
 - 3. The manufacturer shall provide written specifications showing let-through voltage of the unit with six inches of lead length (at the module or at the lug data is not acceptable as it does not represent true "as installed" performance) pursuant to ANSI/IEEE C62.41 and C62.45, 2002, categories A1 & A3 ring wave, 180 degree phase angle, category B3 Ringwave, and UL

suppressed voltage ratings, 90 degree phase angle, positive polarity, measurements in peak voltage from the zero reference, all dynamic tests except N-G, which shall be no higher than:

ANSI/IEEE C62.41-1991 Measured Limiting Voltage

A1 Ring Wave (2kV, 67A)	Tested at 18	0 degree pl	hase ang	gle	
Voltage (Voltage Code)		L-N	L-G	L-L	N-G
120/240 (1S240)		29V	46V	39V	40V
120/208 (3Y208)		29V	46V	39V	40V
277/480 (3Y480)		34V	54V	40V	39V
A3 Ring Wave (6kV, 200A)	Tested at 18	0 degree pl	hase ang	gle	
Voltage (Voltage Code)		L-N	L-G	L-L	N-G
120/240 (1S240)		56V	61V	88V	112V
120/208 (3Y208)		56V	61V	88V	112V
277/480 (3Y480)		66V	115V	83V	94V
B3 Ring Wave (6kV, 500A)	Tested at 90	degree pha	ase angl	е	
Voltage (Voltage Code)		L-N	L-G	L-L	N-G
120/240 (1S240)		437V	592V	612V	324V
120/208 (3Y208)		437V	592V	612V	324V
277/480 (3Y480)		670V	785V	1020V	324V
UL Voltage Protection Ratin	gs				
Voltage (Voltage Code)	-	L-N	L-G	L-L	N-G
120/240 (1S240)		700V	700V	1000V	700V
120/208 (3Y208)		700V	700V	1000V	700V
277/480 (3Y480)		1200V	1200V	2000V	1200V

- 4. The unit shall have a peak surge current of no less than 120kA/phase, 60kA/mode, 8 X 20 us waveform, single impulse, verified by third party test reports.
- 5. Internal Fusing Overcurrent Protection:
 - a. Each Metal Oxide Varistor, or other primary suppression component, shall be individually fused for safety and performance to allow the SPD to withstand the full rated single pulse peak surge capacity per mode without the operation or failure of the fuses. Overcurrent fusing that limits the listed peak surge current of the SPD is not acceptable. Replaceable cartridge type per phase or per mode overcurrent fusing is not acceptable where there is more then one MOV per mode.
 - b. For arc quenching capability, minimization of smoke and contaminates in the event of a failure, and to ensure the safest possible design, all surge components, current carrying paths and fusing shall be packed in fuse grade silica sand.
 - c. Fusing shall be present in every mode, including Neutral-to-Ground.
 - d. The fusing shall be capable of interrupting up to a 200kA symmetrical fault current with 600VAC applied.
- 6. The SPD shall be capable of attenuating internally generated ringing type transients and noise, and shall have an enhanced transient filter supported by a specification sheet which lists the IEEE A1 Ring Wave let-through levels no higher than those set forth above.
- Because of space limitation, the enclosure shall not exceed 4.0" D x 4.0" W x 10.3" H to allow close-to-the load installation on flush mount panels and between adjacent panelboard. For recessed panels, a flush mount cover plate shall be provided with each unit.

- 8. The suppressor shall include Form C dry contacts (N.O. or N.C.) for remote monitoring capability, and shall have at minimum a Nema 1 steel enclosure.
- 9. The SPD shall come standard with not less than a Thirty Year Warranty, and the warranty shall include unlimited free replacements of the unit if destroyed by lightning or other transients during the warranty period. Special or optional warranties in excess of the unit's standard warranty for purposes of this bid are not acceptable.
- 10. The SPD shall have an internal audible alarm with mute on front cover.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install the SPD's with the conductors as short and straight as practically possible. <u>Utilize TPS</u> <u>Low-Z cable assembly for connection where extended wire lengths are required.</u>
- B. Follow the SPD manufacturer's recommended installation practice as outlined in the equipment installation manual. The electrical contractor shall ensure that all neutral conductors are bonded to the system ground at the service entrance or the serving isolation transformer prior to installation of the associated SPD.
- C. Distribution, branch panel, and motor control center units shall be installed on 30 amp dedicated circuit breakers, or, where indicated, shall be wired directly to the main lugs or feed through lugs, or wired directly to the bus bars.
- D. The installing contractor shall comply with all applicable codes.

END OF SECTION 26 4313

SECTION 27 0010 TECHNOLOGY GENERAL PROVISIONS

PART 1 - GENERAL

1.1 GENERAL CONDITIONS AND DEFINITIONS

- A. Scope: This specification section applies to all Division 27 specification sections and all Division 28 specification sections with the exception of Fire Alarm. All systems under the specifications indicated above are referenced also in this contract documents as "technology systems".
- B. Drawings and specifications: The words "drawings" and "specifications" used on this section refer to all contract drawings and specifications describing the scope of work of the technology system.
- C. Installer and Contractor: The word "installer" where used on the drawings or specifications without any further description shall reference the installer of the system under reference. The word "contractor" where used on the drawings or specifications without any further description shall reference to the General Contractor (or Construction Manager) holding the prime agreement with the owner for the construction of this project.
- D. Provide and Install: The word, "provide" where used on the drawings or specifications shall mean, "furnish, install, mount, connect, test, complete, document and make ready for operation". The word "install" where used on the drawings or specifications shall mean, "mount, connect, test, complete, and make ready for operation".
- E. The word Engineer (also referenced as A&E) where used on the drawings or specification refers to the design engineer of the project working for the project architect or the owner. It does not refer to an engineer working for the General contractor, Construction Manager or any of the installers in the project.
- F. Complete systems: All technology systems are intended to be complete systems, including all materials, labor and programming to make it an operation system. A Responsibility matrix has been included with the contract documents to clarify the scope of all systems. Refer to the Technology Drawings for the Responsibility Matrix.
- G. Active equipment: Active equipment is defined as equipment composed of electronic component and electric materials, design to work with power applied to it. Cables are not considered active equipment.

1.2 INTERPRETATION OF DRAWINGS AND SPECIFICATIONS

A. Objective: The intent of the design drawings and specifications is to provide the installer of a technology system a scope of work for bidding purposes and to make sure different bids received by the entity holding the bidding for the technology system are at the same level of scope for comparison purposes. The drawings and specifications are not intended to show every single element of the project to produce a buyout list for the installer. In general, for all technology systems, all active components are specifically called out but small wires and small installation materials (such as nut, bolts, washers, termination blocks, clamps, ties, etc) are not indicated in the documents. Guidelines for installation of those systems are provided in the specification to allow the installer to produce the complete buyout list of materials.

TLC Engineering Solutions

Project No. 121505 Technology General Provisions Section 27 0010 - 1

- B. Accuracy: The Drawings are diagrammatic and are not intended to show exact locations of conduit runs, outlet boxes, junction boxes, pull boxes, etc. The locations of equipment, appliances, fixtures, conduits, outlets, boxes and similar devices shown on the Drawings are approximate only. Exact locations shall be as accepted by the Architect or Engineer during construction. Obtain in the field all information relevant to the placing of technology systems work and in case of interference with other work, proceed as directed by the Architect or Engineer.
- C. Distances: Although most drawings have a scale referenced on each sheet, the drawings are a two dimensional representation of the system, so design drawings do not indicate changes in elevation that cause additional lengths and quantities of materials. It is the responsibility of the installer of each technology system to field verify all distances before bidding to properly estimate all cable distances and materials.
- D. Discrepancies: Notify the A&E of any discrepancies found during construction of the project and do not proceed with that portion of the project, until a written definitive statement is received providing clear direction. If a conflict exists between the contract documents and any applicable code or standard, the most stringent requirement shall be included for this project. The Engineer shall make the decision regarding questionable areas of conflict.
- E. Existing Conditions: All existing conditions might not be indicated in the design drawings. The installer of each system shall check site and existing conditions thoroughly before bidding and advice the Engineer of discrepancies prior to bid.
- F. Coordination: Although design technology drawings were intended to be coordinated with other trades, the fact that installer for other non-technology system might have changes to their design drawings, requires the Contractor to produce coordination drawings for a specific space, including all elements of all trades for space planning and coordination purposes.

1.3 ABBREVIATIONS

- A. Abbreviations: The following abbreviations or initials may be used:
 - 1. ABV CLG Above Ceiling
 - 2. AC Alternating Current
 - 3. ADA American Disabilities Act
 - 4. AFF Above Finished Floor
 - 5. AFG Above Finished Grade
 - 6. AMP Ampere
 - 7. ANSI American National Standards Institute
 - 8. AWG American Wire Gauge
 - 9. BC Bare Copper
 - 10. CCTV Closed Circuit Television
 - 11. CATV Community antenna television
 - 12. CLG Ceiling
 - 13. COAX Coaxial Cable
 - 14. CPU Central Processing Unit
 - 15. DC Direct Current
 - 16. DEG Degree
 - 17. EMT Electrical Metallic Tubing
 - 18. GND Ground
 - 19. IDF Intermediate Distribution Frame (Telecom Room)
 - 20. IMC Intermediate Metallic Conduit
 - 21. IN Inches
 - 22. IP Internet Protocol

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 121505 Technology General Provisions Section 27 0010 - 2

- 23. JB Junction Box
- 24. KVA Kilo-Volt-Amps
- 25. KW Kilowatts
- 26. LBS Pounds
- 27. LED Light Emitting Diode
- 28. MAX Maximum
- 29. MDF Main Distribution Frame (Main Telecom Room)
- 30. MIC Microphone
- 31. MIN Minimum
- 32. MTD Mounted
- 33. MTG Mounting
- 34. NEC National Electrical Code
- 35. NECA National Electrical Contractors Association
- 36. NEMA National Electrical Manufacturers Association
- 37. NFPA National Fire Protection Association
- 38. NIC Not in Contract
- 39. OFE Owner furnished equipment
- 40. OSHA Occupational Safety and Health Administration
- 41. PB Pullbox
- 42. PWR Power
- 43. PVC Polyvinylchloride
- 44. EF Telecommunications Entrance Facility
- 45. TR Telecommunications Room
- 46. TTB Telephone Terminal Board
- 47. V Volt
- 48. WP Weatherproof

1.4 CODES AND STANDARDS

- A. Application: The codes, standards and practices listed herein generally apply to the entire project and all technology systems. Other codes, standards or practices that are more specific will be referenced within a particular specification.
- B. Requirements: All articles, products, materials, fixtures, forms or types of construction covered in the specifications will be required to meet or exceed all applicable standards of manufacturer, testing, performance, capabilities, procedures and installation according to the requirements of ANSI, NEMA, IEEE, NEC, BICSI and TIA referenced documents where indicated and the manufacturer's recommended practices. Requirements indicated on the contract documents which exceed but are not contrary to governing codes shall be followed.
- C. Compliance and Certification: The installation shall comply with the governing state and local codes or ordinances. The completed technology system installation shall be inspected and certified by all applicable agencies that it is in compliance with all codes.
- D. Applicability: The codes and standards and practices listed herein, and their respective dates are furnished as the minimum latest requirements. List of applicable codes:

US Virgin Islands.

- E. Utility Company: Comply with latest utility company regulations.
- F. Building Code: International Building Code 7th Edition (2020).

G. UL Labels: All materials shall be new and free of defects, and shall be U.L. listed, bear the U.L. label or be labeled or listed with an approved, nationally recognized Electrical Testing Agency. No equipment shall be installed if there is no labeling or listing service is available for such equipment.

1.5 MATERIALS ALTERNATES AND SUBSTITUTIONS

- A. Definitions:
 - 1. Basis of design: A product or group of products from an identified manufacturer that was used as the basis of systems layouts and installation details, part of the contract documents.
 - 2. Prototype: Is a product or a group of products that are not yet ready for commercial use because they are in the testing phase (Beta testing) of the product development.
 - 3. Alternates: Products or manufacturers listed in the contract documents as acceptable compare to the basis of design. Use of alternates shall follow the same system architecture as the basis of design.
 - 4. Obsolete: A product that has been discontinued by the manufacturer or declared in end of life, and it is no longer being manufactured.
 - 5. Substitution: A product not listed in the contract documents but capable of similar characteristics as the basis of design operating as a direct replacement in the system in reference. The installers can propose a substitution if all requirements are met as indicated in this specification.
 - 6. Substitutions that create a change in system architecture are products that create a very different system configuration impacting other trades (i.e. change in power/cooling requirements, changes in raceways layout or sizes, changes in equipment space requirements, changes in low voltage wiring layouts, types and quantities, etc) but providing a similar end result as the system/products basis of design.
- B. Use of Prototype. Prototypes are not allowed in any technology system.
- C. Use of alternates. Alternates are allowed and installer shall follow these requirements:
 - 1. Where several brand names make or manufacturers are listed as acceptable alternates each shall be regarded as equally acceptable, based on the design selection. Where a manufacturer's model number is listed, this model shall set the standard of quality and performance required. Where no brand name is specified, the source and quality shall be subject to Engineer's review and acceptance. Where three or more manufacturers are listed, one of the listed manufacturers shall be submitted for acceptance.
 - 2. The use of alternate products does not allow the change of system architecture with such products.
- D. Use of substitutions. Substitutions are only allowed when they meet all the requirements below:
 - 1. Substitutions are only allowed when a particular specification section for a technology system, allows the use of substitutions for that particular system.
 - 2. The performance of all substitutions components must meet or exceed those of the basis of design. Should an installer wish to submit a substitution product or a product set stated in the construction documents as 'acceptable', it shall be the responsibility of the installer to submit to the Engineer an item-for-item CROSS REFERENCE for all specifications of the product, all related specifications and product data sheets, for the proposed substitution. Use the substitution request form indicated in Attachment 1 of this specification.
 - 3. The Engineer has the authority to reject a substitution without cause and the installer shall provide the basis of design and no additional compensation.
 - 4. Substitutions of unnamed manufacturers will not be acceptable.

- 5. Certification of substitutions: When a basis of design is specified to be in accordance with a trade association or government standard requested by the Engineer, installer shall provide a certificate that the substitution complies with the referenced standard. Upon request of Engineer, Contractor shall submit supporting test data to substantiate compliance.
- 6. Substitutions that create a change in system architecture are not allowed

1.6 SHOP DRAWINGS AND SUBMITTALS

- A. General: Shop drawings shall be submitted for equipment and material as indicated in the individual specification sections for each system.
- B. Quantity of shop drawings submittals: Follow Division 1 requirements for quantity of shop drawings and submitting requirements. If the project does not have a Division 1 specification, shop drawings shall be submitted in quantity of one (1) for electronic format submittal.
- C. Electronic submittals. Submittals in electronic format (PDF) are accepted.
- D. When cut sheets of products are submitted and the manufacturer cut sheets indicate several model numbers or variations of the same product, the cut sheet shall be highlighted by the installer to indicate the specific product that will be provided for this project. Submittals received with cut sheets indicating multiple parts numbers and not highlighted will be rejected and not reviewed.
- E. Equipment and material quantities are not reviewed by the A&E as part of this submittal process. Equipment quantities are to be provided by the installer as indicated in contract documents. Approved shop drawings indicating any changes in equipment quantities or overall scope of work different from contract documents does not constitute approval by the A&E of those changes. The contract documents and any changes issued by the A&E in the form of Supplemental Information during the construction process are always to be followed for equipment quantities and scope of work.
- F. All electronic equipment prone to obsolescence and with lead times less than 3 months shall be submitted for approval no sooner than 12 month before the date set for substantial completion of the project. Electronic equipment prone to obsolescence includes devices like flat panel displays, transceivers, servers, players, workstation and routers
- G. Equipment and materials installed not in accordance with the approved shop drawings shall be replaced at installer's expense.
- H. Multiple stages of shop drawings shall be required as indicated in each specification section. For final completion and testing the installer shall provide a submittal with the following information:
 - 1. Detailed course syllabus for each type of training required in the specifications
 - 2. A proposed schedule of training sessions in compliance with the specification sections and indicating place where the training will take place.
 - 3. A copy of all training material to be used during each session.
 - 4. Test result sheets for all testing done by the installer prior to the system acceptance test.

PART 2 - PRODUCTS

2.1 IDENTIFICATION AND LABELING TAGS

- A. All conduit, cabinets, cables, wires, wiring forms, terminal blocks, and terminals shall be clearly identified with pre-printed, self laminating labels or tags.
- B. For labeling of cables or equipment in outdoor environments use only marker plates attached to cable or equipment with cable ties. Do not use any labels with adhesive materials. Use different color plates for different cable types. Use only waterproof ink for writing on marker plates.
- C. Any type of write-on labels (except for outdoor marker plates), hand writing on cable jackets or directly on equipment, labels made with masking tape or any other type of tape not listed in previous paragraph are not acceptable and shall be corrected with approved labeling methods at no additional cost to the owner.
- D. Approved manufacturer:
 - 1. Rhino,
 - 2. Brady,
 - 3. Panduit or
 - 4. approved equal

2.2 TECHNOLOGY EQUIPMENT AND MATERIALS

- A. General: Each item of equipment or material shall be manufactured by a company regularly engaged in the manufacturer of the type and size of equipment, shall be suitable for the environment in which it is to be installed, shall be approved for its purpose, environment, and application, and shall bear a label as indicated in paragraph 1.4.E. of this section.
- B. Installation Requirements: Each item of equipment or material shall be installed in accordance with instructions and recommendations of the manufacturer and the contract documents.
- C. Required Accessories: All equipment specified in the technology systems shall be provided with all required accessories for proper operation and mounting. Typically these accessories are not specifically indicated in the design drawings but shall be provided per this specification section. Such accessories include items such as power supplies, power cords, rack ears, rack rails, bolts, lugs, faceplates, etc.

PART 3 - EXECUTION

3.1 INSTALLATION PRACTICES

A. WORKMANSHIP: The installation of materials and equipment shall be performed in a neat, workmanlike and timely manner by an adequate number of craftsmen knowledgeable of the requirements of the Contract Documents. They shall be skilled in the methods and craftsmanship needed to produce a quality level of workmanship. Personnel who install materials and equipment shall be qualified by training and experience to perform their assigned tasks.

- B. STANDARD OF QUALITY: To define good workmanship, all installation practices described in BICSI standards shall be followed.
- C. PROTECTION OF EQUIPMENT: Equipment for Technology systems shall at all times during construction be adequately protected against mechanical/chemical damage by the elements or work perform by other trades. Equipment shall be stored in dry permanent shelters. If equipment or materials has been damaged, such equipment shall be replaced at no additional cost or time extension to the Contract. Damaged equipment and materials include the following conditions:
 - 1. Equipment that has visible scratches, cracks or equipment that has paint or finished surface peeled off.
 - 2. Equipment with visible indication of rust or water intrusion.
 - 3. Equipment that has dents on the metal enclosures and are clearly visible to the end user.
 - 4. Equipment that has been sprayed with paint, fire proofing materials, or other type of chemicals, when the equipment was not intended to have this type of materials applied to it, per contract documents.
 - 5. Equipment that has been burnt by controlled fires, power surges, power sags or by lightning.
 - 6. Equipment that has a known damage to any parts, electronic board or component, even if such component or board has no specific use in the project.
 - 7. Cables that have visible damages to the jackets even if cables are not broken and still provide electrical continuity.
 - 8. Cables sprayed with paints that affect the warranty of the cable as defined by the cable manufacturer.
 - 9. Equipment with screws with stripped heads.
- D. CLEAN EQUIPMENT: All equipment installed in spaces accessible to the building occupants like in racks, cabinets, wall mounted panels, credenzas, etc. shall be free of dust at the time the space part of the project gets the final Certificate of Occupancy and at the time of the acceptance test by the A&E. A clean equipment is defined as an equipment that if wiped with a finger, in any surface, does not leave visible debris and dust in the finger, also equipment with no visible signs of dust inside the equipment, like in ventilation fans.
- E. IDENTIFICATION AND TAGGING: All technology systems items shall be labeled and identified as specified in the Contract Documents. Such identification shall be in addition to the manufacturer's nameplates and shall serve to identify the item's function and the equipment or system which it serves or controls. Refer to Identification Section of the specifications for additional information. All labels of equipment and wiring shall match the labeling used in the shop drawings for the system.

3.2 COORDINATION

- A. General: The installer shall compare shop drawings with those of other trades and report any conflicts between them to the A&E. Obtain from the A&E written instructions to make the necessary changes in any of the affected work. All work shall be installed in cooperation with other Trades installing interrelated work.
- B. Adjustments: Locations of conduit and equipment shall be adjusted to accommodate the work with interferences anticipated and encountered. Determine the exact routing and location of all systems prior to fabrication or installation.
- C. Replacement: All work shall be installed in a way to permit removal (without damage to other parts) of all other system components provided under this Contract requiring periodic

replacement or maintenance. All conduits shall be arranged in a manner to clear the openings of swinging overhead access doors as well as ceiling tiles.

3.3 REQUEST OF IP ADDRESSES

- A. General: When contract document require the installer of any of the technology systems to use IP addresses for the configuration of such system, inside the owner's controlled IP network, the installer shall request the owner to provide such IP addresses. The installer shall request such information no less than two (2) months in advance from the moment the installer will be programming the system and by using the form named "Network Connections Programming Plan" indicated in Attachment 3 of this specification. An electronic copy of this form is available upon request from TLC Engineering.
- B. Completing the form. The Network Connections Programming plan shall be completed in separate by each trade that requires IP addresses. This form has two parts. The first part indicates all the different device types for a system (i.e. cameras, workstation, servers, controllers, VoIP phones, etc). The second part is a list of all devices required classified by their type and properly indicating location where the device will be used.
- C. Request that do not follow this process, or have incomplete information will be ignored and will not be processed.
- D. Reprogramming cost of any technology systems due to un-approved addresses used by the installer shall be at the installer's expense

3.4 TELECOM ROOM/EQUIPMENT ROOM READINESS

- A. In any projects where the technology systems require the use of network equipment (switches, routers, firewalls, etc) provided by the owner, the Contractor shall complete all telecom rooms to a point where they are suitable for the owner to deploy such equipment in those rooms. At a minimum the following conditions shall be meet at all rooms in order for the owner to install the equipment:
 - 1. All power outlets in the telecom rooms shall be fed from the permanent source of power. Temporary power shall not be accepted.
 - 2. Backup power (generator and/or UPS) shall be already operation, tested and connected to the final power distribution system.
 - 3. The mechanical equipment providing the cooling for the telecom rooms shall be fully operational. Temporary cooling shall not be accepted.
 - 4. Fire suppression system (sprinkler or gas based system) protecting the telecom rooms shall be fully operational and tested.
 - 5. All light fixtures in the telecom rooms shall be fully operational.
 - 6. All walls to the telecom rooms shall be completed and including the last coat of paint.
 - 7. The ceiling and flooring of the telecom rooms shall be finished.
 - 8. All horizontal and backbone cabling system part of the structured cabling system (SCS) shall be installed, terminated and tested.
 - 9. The final and permanent doors to the telecom rooms shall be installed with a key core different from all other construction cores in the site.
 - 10. Telecom rooms shall be cleared of any materials being stored inside the room.
 - 11. Telecom rooms shall be clean. Clean will be measured as not having any debris left in the room and not having dust in rack, cabinets, or wall mounted panels. If wiping a finger in any of the surfaces of such equipment leaves visible dust residue in the finger, the room will not be considered clean.

- 12. Hallways and rooms leading into the telecom rooms shall have no more sanding to be done in the walls and the floor shall be completed to avoid dust from these spaces moving into the telecom rooms.
- 13. Prior to the owner deploying the equipment in these rooms, the Contractor shall provide disposable sticky mats at the entrance of each telecom room to capture dust and/or dirt from people's shoes or boots coming into the room. The sticky mats shall be selected as to cover the width of the door opening. Sticky mats shall contain no less than 60 sheets in each unit. Used sheets of the mats shall be replaced no less than on a daily basis or if worn out before the end of the day. Sticky mats shall be provided until the project receives the final Certificate of Occupancy.

3.5 SYSTEMS WARRANTY AND SERVICE

- A. General: At a minimum all technology system shall include a warranty from the manufacturer and installer of the system for no less than three (3) years with the following exceptions:
 - 1. Structured Cabling system shall have a warranty longer than three years as indicated in that specification section.
 - 2. When specific equipment or software manufacturers include a warranty longer than three years, the manufacturer's warranty shall be transferred to the owner in the same terms as indicated by the manufacturer.
- B. Warranty coverage. The warranty for the technology system shall cover the following elements:
 1. All equipment parts, cabling and materials.
 - 2. Any software updates/patches issued during the warranty period by the manufacturer.
 - 3. The labor to replace those parts and programming time to re-configure equipment.
 - 4. Shipping and freight charges to send equipment back and forth from the manufacturer and/or site.
 - 5. Tool rentals such as scaffold or lifts to access equipment.
 - 6. The troubleshooting time to detect the faults in the system.
 - 7. All travel time and expenses associated with the service.
- C. Start of warranty. The warranty period for the technology systems starts the day the project gets the Certificate of Occupancy (CO), for new construction projects and when the project is accepted by A&E, whichever occurs later. For most equipment/software manufacturer's the warranty period starts when the equipment is shipped from the factory, so it is the responsibility of the installer of each system to provide additional warranty coverage from the manufacturer to cover the additional time of warranty.
- D. Service calls. During the warranty period the installer shall support the system when called by owner/contractor for service. All equipment/software service shall be done by personnel with the same qualifications as the personnel who installed the system and as indicated in each technology system specification section. Service calls shall be taken during business hours (same time zone as the project) for normal service and twenty (24) hours three hundred and sixty five (365) days in the year for emergency service. Emergency Service shall be defined as the loss or failure of any critical component necessary to maintain the overall integrity and operation of the system. Normal service shall be defined as the loss or failure of a system component that does not compromise the complete operation of the system and allows the owner to operate the system at a minimum of 90% of its capacity. See individual specification sections for delineation on critical components and normal service.
- E. Response time for service. The maximum allowed response time after a service call for emergency service shall be eight (8) hours and for normal service twenty four (24) hours.

- F. Equipment registration. All equipment/software part of the technology system shall be registered to the owner with the manufacturer of the equipment/software for warranty and support. Equipment/software registered with the manufacturer to the name of the Contractor or installer shall be removed from the project and replaced with equal equipment registered to the owner at no additional cost to the owner.
- G. Periodic preventive maintenance visits. During the warranty period the installer of the system shall provide no less than two (2) preventive maintenance services. These services shall be provided at 6 months from start of the warranty period and a few weeks before the end of the warranty period. The installer of the system shall coordinate with the owner the precise dates for this type of service. During these visits the following task shall be perform:
 - 1. Clean up of any active equipment that shows visible accumulation of dirt, dust of debris of any kind.
 - 2. Replacement of any consumable parts in the system that require replacement per manufacturer's instructions during the warranty period, such as filters.
 - 3. Oiling/greasing of any mechanical parts that require period maintenance as per manufacturer's instructions during the warranty period.
 - 4. Run manufacturer's recommended test for each piece of equipment installed. The installer shall provide at the end of the service a report of such test.
 - 5. Visual observation of all devices in the system to spot any anomalies.
 - 6. Review of error logs from any system components and analysis of such logs with explanation to owner on the cause of those errors.
- H. Extended service agreement. Prior to final acceptance testing, and within thirty 30-days of project completion, the installer of each technology system shall submit to the Owner an option to purchase extended service coverage. This proposal shall provide for the purchase option of 1, 3, or 5, year coverage. Coverage shall include, at a minimum, the same provisions as during the warranty period.

3.6 ENGINEER'S FINAL ACCEPTANCE TEST

- A. The technology systems shall be tested during installation by the installer as frequently as required to solve any installation issues and non compliance of system specifications. Technology systems will not be considered delivered to the owner until final acceptance test is passed. The final acceptance test shall be done in presence of the A&E and/or the owner. The installer shall request in writing with 2 weeks in advance the presence of the A&E and/or owner for the final acceptance test.
- B. In order for the installer of the system to request final acceptance the following task shall be completed:
 - 1. All components shall be inspected to ensure they have been properly installed by the installer, securely attached, and remain clean and unmarred
 - 2. All equipment shall be properly adjusted, clearly labeled, and fully operational.
 - The installer shall have tested the system previously to ensure the final acceptance test will be successful. Detailed proof of test shall be sent to the A&E with the request for final acceptance
 - 4. All permanent and final labels as requested in the identification and tagging section of this specification are completed.
 - 5. No temporary conditions shall be present in the system.
 - 6. All batteries on all system components shall be connected.
 - 7. All system programming shall be completed as indicated in the specification for each technology system.

- C. All test equipment required for the Final acceptance shall be provided by the installer of the system unless specifically indicated by the A&E.
- D. The A&E shall define the scope of the testing but the installer shall be prepared for testing every single component of the system. During the day of the test the A&E will indicate the testing process and procedures for each system. Test could include operation of the system during power outages. The installer of the system shall be available during the complete testing process to answer questions from the Engineer and to demonstrate specific parts of the system. If personnel form the installer or test equipment is not available, the test will be considered and marked as a failure.
- E. A punch list of the items to be corrected will be prepared by the A&E during the final acceptance test. The installer shall correct all items and request a second day for verification of all punch-list items by the A&E and Owner. During the second test, no additional punch list items shall be expected, and only the items in the punch list will be tested.
- F. If during the testing process the A&E and/or Owner consider that the rate of failure of the test is too high (more than 5 failures or non-compliance with specifications in one hour of test), the test will be cancelled unilaterally by the A&E and/or owner. The installer shall correct all items and re-schedule the final acceptance test again. The new test will start over from the beginning and nothing previously tested will be accepted. The installer shall not be entitled to additional compensation for the additional effort to test the system during this condition. To the contrary, the Contractor/Installer shall reimburse the owner of the project with the cost of the additional hours of testing required to be spent by the A&E and owner's team. The rate to be used for this reimbursement will be \$150 per hour per person required by the A&E and Owner to complete the test.
- G. Upon successful completion of the final acceptance test the installer of the system will receive a written notice by the A&E and/or Owner acknowledging the acceptance of the test
- H. See individual specification sections for system specific requirements for testing.

3.7 TRAINING AND INSTRUCTION

- A. Training for each technology system shall be provided as indicated in this specification and in the individual specification section for each system.
- B. The following training guidelines shall be followed for all technology system
 - 1. Training shall not be scheduled in a way that no attendee or presenter shall be required to attend more than 6 hours of training per day.
 - 2. Prior to starting all training, the training submittal shall be approved. See section one of this specification for details on the training submittal
 - 3. No training shall be scheduled prior to the system being completed and accepted by the A&E.
 - 4. Training shall be conducted during normal business hours of the client, at a date and time of mutual convenience to the Owner and installer. All training sessions need to be scheduled by the installer at least 2 weeks in advance. The Owner shall be notified in writing by the installer on when are the possible dates for each session.
 - 5. All different types of training shall be videotaped and delivered to the owner as part of the close out information in digital copy. All tapes shall be recorded in hi-quality MPEG2 or HD recorders, and the media turned to the owner shall be in electronic format viewable through QuickTime or Windows Media Player.
 - 6. The installer is responsible for completing list of attendants for each session of training. All these sheets shall be submitted as part of the close out information

3.8 AS BUILT DOCUMENTS

- A. Production: During the course of this project the contractor shall maintain record "as-built drawings". One set shall be maintained at the site and at all times and it shall be accurate, clear, and complete, showing the actual location of all equipment as installed. The "As-Built" drawings shall show all technology systems work installed complete to the present stage of progress. These drawings shall be available for review by the A&E's field representatives at all times.
- B. Completion: At the completion of the Work, transfer onto the second set of drawings all changes marked in colored and submit to the A&E.
- C. Final: Upon installer's completion of the Engineer's final punch list, transfer all "As-Built" conditions and all requirements by the Engineer to a reproducible set of drawings. Submit electronic drawings in PDF format and CAD/Revit© for review and acceptance.
- D. Additional documents. At project completion, the installer of the technology system shall provide, as part of the as-built documents, updated tables, equipment schedules, configuration worksheets and labeling system used. See individual system specification section for more details on these documents.
- E. See individual specification sections for each system for additional requirements for As-Built documents.

3.9 CLOSE OUT DOCUMENTS

- A. Closeout information shall be provided to the owner in electronic format at the end of the project. The file shall be organized by each system and shall follow this organization:
 - 1. PART 1 OPERATION AND MAINTENANCE MANUALS. Operation and Maintenance manuals as issued by the manufacturer of each system's component. Such manuals shall include all maintenance procedures required to be done by the owner. Also, when required by each individual specification section, a short form operation guide, prepared by installer) for the system.
 - PART 2 INVENTORY OF EQUIPMENT INSTALLED. A detailed list of all relevant active equipment (equipment with electronic components with a market value over \$200) installed in the project including the following information and presented in electronic format (Microsoft Excel):
 - a. Make
 - b. Model
 - c. Serial number
 - d. Room location
 - e. Warranty period, including manufacturer's extended warranties.
 - 3. PART 3 PROOF OWNERSHIP, DELIVERY AND ACCEPTANCE. The following letters/documents shall be attached in this part:
 - a. Acceptance letter signed by A&E for each of the technology systems installed.
 - b. Proof of training by submitting sign in sheets for each training session done
 - c. Signed transmittal for all training videos and training material.
 - d. Signed transmittal for all spare parts and consumables delivered to the owner.
 - e. A list of all the user names and passwords for all the different software programs used by the technology systems and any equipment with password codes. All levels of passwords shall be provided, from the lowest hierarchy to the highest.
 - f. At least four (4) copies of all physical keys to different devices part of the technology systems. Each key shall be individually tagged in a key ring. All keys shall be included and organized inside a key ring management enclosure.

- g. A list of all software modules and licenses delivered to the owner. The list shall include part numbers, serial numbers, license certificate of authenticity, hardware key (dongles) numbers and software version. This list shall have a clear signature, name and date on person that received this software by the Owner.
- h. A copy of all official equipment and software registrations with manufacturer.
- 4. PART 4 AS BUILT DOCUMENTS. All as-built documents as indicated in this specification section

END OF SECTION 270010

ATTACHMENT 1 – SUBSTITUTION REQUEST FORM

Substitution Request Form	Request No.:	Date:
Project:	Specified Manufacturer:	Proposed Manufacturer:
Spec Section:	Specified Model No.:	Proposed Model No.:
ltem(s):	Reason(s) for not providing speci	fied item:
*Please attach product descri informat	ption, drawings, photographs, perf ion necessary for side-by-side evalu	formance and test data, samples, and other uation. Fill in all blanks.

Provide substantiated reason for requested substitution below.

Does the requested substitution affect dimensions, locations, or configurations? (Yes/No) Please explain below (attach drawings if necessary).

What are the differences between the specified item and the requested item? Please list below.

Will the Contractor pay for any changes to the building design, including engineering and detailing costs caused by the approval? (Yes/No)

If no, explain below. Describe modifications required to install or accommodate the requested change.

Will approval affect the work of other trades, including the Construction schedule? (Yes/No) If yes, please explain below. Manufacturer's guarantees of the proposed and specified items are: (Same/Different) If different, please explain below.

Does the proposed item meet all applicable codes, ordinances, and regulations for this specific application? (Yes/No)

If no, please explain below.

Has the proposed item been used locally in similar applications? (Yes/No) If yes, please explain below and give nearest location.

Will maintenance and service parts be locally available for the requested item? (Yes/No) Please explain below. If not locally available, give nearest location.

Will the requested item require waiving of any qualifications or other requirements? (Yes/No) If yes, please explain below.

Are there any license fees or royalties associated with the requested substitution? (Yes/No) If yes, please explain below.

If approved, will the Owner receive a credit for the proposed alternate material? (Yes/No) If no, please explain below.

Does the proposed alternate material meet the same applicable standards (ASTM, ANSI, UL, FS) as the specified item? (Yes/No)

If no, please explain below (attach drawings if necessary).

Identify the recycled materials or components or features that lead to the claims to being "Green":

Has the required line-by-line comparison been included? (Yes/No) If no, please explain below.

The following Purchase Order or billing number is to be used for billing the Contractor for costs incurred in evaluating and if applicable accommodating the requested substitution:

The undersigned agrees to pay for the Designer's review time and for changes to the building design, including review, re-design, engineering, drawings, and other costs caused by the requested substitution.

Signature

Name (please print)

The Engineer will not be required to approve any product that is not equal or suitable for the specific application and functionality of this project.

	z
NS	PLA
ō	DNI
5	ΣM
Ы	GRA
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ER	OIL
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PROJECT NAME						
DATE						
SUBCONTRACTOR						
TRADE						
	TYPE OF DEVIC	ES FORM (Fill o	ne column per d	evice type provi	ded)	
	DEVICE NAME		DEVICE NAME		DEVICE NAME	
	DEVICE CODE	А	DEVICE CODE	B	DEVICE CODE	С
Manufacturer						
Part Number						
Firmware version						
Is a fixed address required or can device work with a dynamic address (DHCP)?						
Does device require an address from a DNS server?						
Does device support Layer 3 traffic (IP)?						
Does device needs access to the internet?						
Number of physical network ports per device?						
Does device require IPv6 to work or IPv4?						
Does device support SNMP?						
Does device need specific TCP ports open? Please list						
Is this device connecting to existing network devices (Yes/no) Server/client application						
If yes to above, please describe to what device, located where.						

Project No. 121505 Technology General Provisions Section 27 0010 - 17

SNC	JG PLAN
OLUTIC	BRAMMIN
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-C ENC	VORK CC
F	NETV

PROJECT NAME							
DATE							
SUBCONTRACTOR							
TRADE							
	LIST OF DEVIC	ES FORM (Fill of	ne entry in form	per each device	s being provided		
DEVICE PHYSICAL LOCATION	DEVICE CODE EROM DREVIOUS FORM	DEVICE NETORK	IP ADDRESS	SUBNET	GATEWAY	DNS SERVER	VLAN

Filled out by Network administrator

SECTION 27 0526 GROUNDING AND BONDING FOR TELECOMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work specified of this section.
- B. General: For grounding electrode system and equipment grounding system for Telecommunications refer to specification section 260526. In all cases the applicable electrical codes for grounding and bonding for telecommunications shall be met.
- C. Supplemental: Refer to the specification sections identified below for additional requirements, which are supplemented by this section.
 - 1. 270010 Technology General Provisions
 - 2. 270528 Raceways for Technology
 - 3. 260526 Grounding and Bonding for Electrical Systems
- D. General. For a bonding diagram for telecommunications refer to T Drawings.
- E. General. The bonding approach required herein is intended to work in concert with the cabling topology as specified in Specification section 271000 and installed in accordance with specification section 270528.
- F. Reference Standards:
 - 1. TIA-607-D
 - 2. TIA-568.0-E
 - 3. TIA-606-C
 - 4. UL 1863 Communication Circuit Accessories
 - 5. NFPA 70 NEC
 - 6. IEEE Std. 1100-1992, Powering and Grounding Sensitive Electronic Equipment.
 - 7. BICSI TDMM, Telecommunications Distribution Method Manual.
 - 8. NFPA 780
 - 9. R56 "Standard and Guidelines for Communications Sites" Motorola Inc. April 2017.
- G. Standard compliance: This project requires compliance with R56 grounding standards for RF distribution (Radio) systems only. The requirements of R56 grounding standards are more stringent and supersede the requirements indicated in this specification section.

1.2 MATERIALS ALTERNATES AND SUBSTITUTIONS

A. General: Substitutions are allowed for all components of the systems under this specification sections as long as all requirements for substitutions indicated in specification section 270010 are followed.

1.3 SHOP DRAWINGS AND SUBMITTALS

- A. See additional requirements for shop drawings and submittals in specification section 270010.
- B. The installer of the Telecommunications Grounding systems shall provide the following information in the shop drawings phase of the project:
 - 1. Manufacturer's cut sheets for all proposed equipment as described in Part 2 of this specification section. Cut sheets shall bear the printed logo or trademark of the manufacturer for each type of product being provided. Mark each copy of the data sheets for the specific product being provided with an identifying mark, arrow, or highlighting.
 - 2. A spreadsheet indicating telecommunications ground bar information selection for each telecommunications room indicated in the design drawings, including the following information:
 - a. Room Name or number
 - b. Quantity of ground bars
 - c. Height of each ground bar
 - d. Length of each ground bar
 - e. Number of holes in each ground bar
 - f. Label for each ground bar
 - 3. A drawing indicating the following information:
 - a. Location of all telecommunications ground bars and routing of all telecommunications grounding backbones.
 - b. Wire size charts for all telecommunications grounding backbones in the project.
 - c. All labels to be used in telecommunications backbone cables, bonding conductors and telecommunications ground bars.

1.4 ABBREVIATONS

- A. General: The following abbreviations are used in this specification section:
 - 1. TBB Telecommunications Bonding Backbone
 - 2. BC Bonding Conductor
 - 3. EMT Electrical Metallic Tubing
 - 4. RMC Rigid Metal Conduit

PART 2 - PRODUCTS

2.1 TELECOMMUNICATIONS MAIN GROUNDING BUSBAR (TMGB)

- A. The TMGB serves as the dedicated extension of the building grounding electrode system for the telecommunications infrastructure. The TMGB shall be located and provided in the Main Telecommunication Room in each building. The TMGB must also be listed by a nationally recognized testing laboratory (NRTL).
- B. The TMGB shall have the following specifications:
 - 1. Material: Copper with a thin platted finish.
 - 2. Thickness: $\frac{1}{4}$ " thick
 - 3. Width: No less than 4"
 - 4. Length: The installer of the grounding system shall estimate the length of the bar as to have enough pre-drilled holes for all BCs in the room. The bar shall be no less than 14" long. The installer shall follow the following criteria in estimating the amount of pre-drilled holes required in the TMGB:
 - a. Two holes required for each TBB termination.

- b. Two holes for each cabinet or rack row in the room
- c. Two holes for each protector block in the room
- d. Two holes for each layer of ladder tray above the rack.
- e. Two holes for each set of conduit sleeves entering the room
- f. 20% of spare capacity shall be available after all terminations are done.
- g. If quantity of holes exceeds the maximum available by a manufacturer, multiple bars shall be provided as to match the criteria indicated above.
- 5. Pre-drilled holes: All pre-drilled holes shall have a diameter of 5/16"
- 6. Hole spacing: All pre-drilled holes shall have a minimum spacing matching the spacing of the holes in the long barrel ground lugs.
- C. The TMGB shall be installed in the wall with stand offs and isolators. Isolators shall be rated at 600V.
- D. Approved manufacturers:
 - 1. Panduit,
 - 2. Erico or
 - 3. approved equal.

2.2 TELECOMMUNICATIONS GROUNDING BUSBAR (TGB) FOR INTERIOR USE

- A. The TGB serves as the dedicated extension of the building grounding electrode system for the telecommunications infrastructure. The TGB shall be located and provided in each telecommunication room (except the main telecommunication room) in each building and any other additional locations as indicated in the drawings. The TGB must also be listed by a nationally recognized testing laboratory (NRTL).
- B. The TMGB shall have the following specifications:
 - 1. Material: Copper with a thin platted finish.
 - 2. Thickness: ¹/₄" thick
 - 3. Width: No less than 4"
 - 4. Length: The installer of the grounding system shall estimate the length of the bar as to have enough pre-drilled holes for all BCs in the room. The bar shall be no less than 12" long. The installer shall follow the following criteria in estimating the amount of pre-drilled holes required in the TMGB:
 - a. Two holes required for each TBB termination.
 - b. Two holes for each cabinet or rack row in the room
 - c. Two holes for each protector block in the room
 - d. Two holes for each layer of ladder tray above the rack.
 - e. Two holes for each set of conduit sleeves entering the room
 - f. 20% of spare capacity shall be available after all terminations are done.
 - g. If quantity of holes exceeds the maximum available by a manufacturer, multiple bars shall be provided as to match the criteria indicated above.
 - 5. Pre-drilled holes: All pre-drilled holes shall have a diameter of 5/16"
 - 6. Hole spacing: All pre-drilled holes shall have a minimum spacing matching the spacing of the holes in the long barrel ground lugs.
- C. The TMGB shall be installed in the wall with stand offs and isolators. Isolators shall be rated at 600V.
- D. Approved manufacturers:
 - 1. Panduit,
 - 2. Erico or
 - 3. approved equal.

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

2.3 TELECOMMUNICATIONS GROUNDING BUSBAR (TGB) FOR OUTDOOR USE

A. When TGB are located outdoors, all specs for indoor used TGB shall be followed with the exception of the construction material. The TGB for outdoor use shall be made of galvanized steel.

2.4 FLEX CONDUCTOR, TWO HOLE, LONG BARREL WITH WINDOW LUG

- A. Flex conductors, two hole, long barrel with window shall be used with TBB and BCs to provide a good bond. All lugs shall be selected to match the size of the conductor being used. Other types of termination are not accepted.
- B. The flex conductor, two hole, long barrel with window lug shall have the following specification:
 1. Finish: Thin platted
 - Cable types: designed to work with Flexible, Extra-Flexible, and Code Stranded Copper Conductors.
 - 3. Stud hole size: ¹/₄"
 - 4. Hole spacing: to match spacing of pre-drilled holes in ground bar or equipment.
 - 5. Barrel length: long barrel > 1"
 - 6. Termination type: crimp type
 - 7. Angle: straight or angled if installation space is limited.
 - 8. Listing: UL listed and tested to 35 KV and 90°C
- C. Flex conductors, two hole, long barrel with window shall be used with BCs in the following cases:
 - 1. Bonding two sections of pathways such as sections of tubular runways or cable trays.
 - 2. Bonding a BC or a TBB to a TGB or TMGB
 - 3. Bonding to equipment that requires two holes for bonding.
- D. Approved manufacturers:
 - 1. Panduit,
 - 2. Thomas & Betts or
 - 3. approved equal.

2.5 HTAP CONNECTOR

- A. When a BC is required to be bonded to another BC of same or different size the only approved method of bonding is with HTAP style crimp connectors. Screw type connectors, wire nuts or any other method are not acceptable. The specifications of the HTAP connectors are:
 - 1. Finish: Thin platted
 - 2. Cable types: designed to work with Flexible, Extra-Flexible, and Code Stranded Copper Conductors.
 - 3. Tap grooves: installer to select HTAP connector based on size of BCs and quantity of BCs to be bonded.
 - 4. Slots: The HTAP connector shall have a lot to support the unit to the bonding conductors with nylon cable ties for initial support before crimping.
 - 5. Termination type: crimp type
 - 6. Listing: UL listed and tested to 600V
- B. Approved manufacturers:
 - 1. Panduit,
 - 2. Thomas & Betts or
 - 3. approved equal.

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

2.6 TELECOMMUNICATIONS BONDING BACKBONE (TBB)

A. Telecommunications bonding backbones shall be provided as indicated in the design documents. TBBs shall be insulated copper stranded conductors with a wire gauge dictated by the length of the cable. The TBB shall be sized according to the table below:

TBB LENGTH LINEAR M (FT)	TBB SIZE (AWG)
Less than 4 (13)	6
4-6 (14 – 20)	4
6 - 8 (21 - 26)	3
8– 10 (27 – 33)	2
10– 13 (34 – 41)	1
13 – 16 (42 – 52)	1/0
16 – 20 (53 – 66)	2/0
20-26 (67-84)	3/0
26-32 (85-105)	4/0
32-38 (106-125)	250 kcmil
38-46 (126-150)	300 kcmil
46-53 (151-175)	350 kcmil
53-76 (176-250)	500 kcmil
76-91 (251-300)	600 kcmil
Greater than 91 (300)	750 kcmil

B. Once a TBB has been sized with a particular gauge, any extensions of such backbone shall not be done with a wire gauge smaller than the previous run regardless of distance.

2.7 BONDING CONDUCTOR (BC)

- A. Boding conductors shall be used to bond equipment and raceways to the telecommunications grounding infrastructure. The specifications of the BC are:
 - 1. Conductor Size: use the chart above for TBB to estimate the size of the bonding conductor. BC shall be no smaller than an AWG-6. For projects with R56 Grounding compliance, BC shall be no smaller than AWG-2.
 - 2. Material: copper stranded conductors.
 - 3. Insulation: Use non-insulated conductors only under raised floor spaces. Insulation color shall be green with a yellow stripe.
- B. Pre-fabricated BCs or field made BCs are acceptable.
- C. Both ends of a BC shall be terminated in long barrel lugs.

2.8 LABELS FOR TELECOMMUNICATIONS GROUNDING INFRASTRUCTURE

A. Installer shall follow labeling materials indicated in specification section 270010.

PART 3 - EXECUTION

3.1 INSTALLATION PRACTICES.

- A. General: Specification section 260526 applies to work of this section. Installation requirements specified herein takes precedence over specification section 260526.
- B. General: All installation requirements indicated in specification section 270010 shall be followed.
- C. PROTECTION. The TBBs and BCs shall be installed and protected from physical and mechanical damage.
- D. GALVANIC CONTINUITY. The TBBs and BCs shall be continuous and routed in the shortest possible straight line path.
- E. BONDING SECTIONS OF TUBULAR RUNWAY OR CABLE TRAY. A bonding jumper with a two hole long barrel lug with window at both ends shall be used to bond adjacent sections of cable tray or tubular runway. The jumper cable shall be no less than 8 inches in length and shall be made of stranded copper cable AWG-6.
- F. CRIMPING. All lugs shall be crimped with the proper die for the size of lug being used.
- G. PAINT REMOVAL. Paint shall be removed before attaching any BC to an equipment with paint in the surface, such as tubular runway and racks, if no ground lug is available in the equipment.
- H. SPLICING. The TBBs and BCs shall be installed without splices. Where splices are necessary, the number of splices should be a minimum and they shall be accessible and located within telecommunications spaces. Joined segments of a TBB or BC shall be connected using exothermic welding, irreversible compression-type connectors, or equivalent. All joints shall be adequately supported and protected from damage.
- I. BONDING TO ELECTRICAL PANELS. The TGB or TMGB shall be as close to the electrical power panel as is practicable and shall be installed to maintain clearances required by applicable electrical codes. The electrical power panel bus or the panel enclosure feeding telecommunications equipment racks/cabinets shall be bonded to the TGB or TMGB.
- J. BONDING TO BUILDING STEEL. All connectors used for bonding to the metal frame of a building shall be listed for the intended purpose.
- K. LUG SCREWS. All connections from lugs to ground bars or grounding equipment shall be done with metal screws with nuts and compression washers. Connections made with metal self tapping screws will not be allowed.
- L. BONDING PROTECTOR BLOCKS. All primary or secondary building entrance protectors' blocks shall be bonded to the nearest TMGB or TGB with a BC. A minimum of 300 mm (1 ft) separation shall be maintained between this insulated conductor and any dc power cables, switchboard cable, or high frequency cables, even when placed in rigid metal conduit or EMT.
- M. BONDING OUTSIDE PLANT CABLES. When the outside plant cables in the Telecommunications Entrance Facility room incorporate a cable metallic shield (armor) isolation gap, the cable metallic shield on the building side of the gap shall be bonded to the TMGB or TGB or the rack/cabinet or the rack's vertical ground bar (if available).

- N. BONDING BACKBONE CABLES. Where backbone cables (fiber or copper) incorporate a shield (armor) or metallic member, this shield or metallic member shall be bonded to the TMGB or TGB or rack/cabinet or the rack's vertical ground bar (if available).
- O. BONDING HORIZONTAL CABLES. When shielded horizontal cable is used and terminated in patch panels, each patch panel needs to be bonded to the telecommunications grounding systems. A BC shall be used between each patch panel and the rack rails of the rack/cabinet or the rack's vertical ground bar (if available).
- P. INTENDED USE OF TBB OR BC. The TBB or BC is not intended to serve as the only conductor providing a ground fault current return path. The intended function of the TBB or BC is to equalize potential differences between telecommunications systems.
- Q. INSTALLATION OF TBBs INSIDE TELECOMMUNICATIONS SPACES. When TBBs are run inside telecommunications spaces they shall be protected from damage by running them inside conduit. Conduit to protect TBBs inside telecommunications spaces can be made of PVC and shall be sized and supported as required by NEC.
- R. INSTALLATION OF TBBS OUTSIDE TELECOMMUNICATIONS SPACES. When TBBs are run outside of telecommunications spaces they shall be protected from damage by running them inside conduit. Conduit to protect TBBs outside telecommunications spaces shall be EMT or RMC. To avoid an electromagnetic choke effect in this conductor, each end of the conduit used to protect the TBB shall be bonded to the TMGB or TGB at each end. Conduit used for protection of TBBs shall be sized and supported as required by NEC.
- S. RACK/CABINET BONDING. All racks/cabinets in the project shall be bonded to the nearest TMGB or TGB inside the room. All rows of rack/cabinets shall be bonded together by a single AWG-2 conductor coming from the nearest TMGB or TGB inside the room. This bonding conductor shall be insulated and run above the racks in the side of the cable tray system, going above the racks, supported by a hanger external to the cable tray. At each rack a bonding jumper (AWG-6) shall be provided and terminated to the rack manufacturer's recommended lug for bonding the rack/cabinet. The bonding jumper shall be connected to the AWG-2 conductor by means of an HTAP connector, protected with heat shrink material. When the system requires R56 grounding compliance, the bonding jumper shall be upsized to an AWG-2 and a vertical ground bar shall be provided for each rack/cabinet from top to bottom of each rack/cabinet. This ground bar shall be the termination point for the bonding jumper for each rack and shall also bond the manufacturer's approved grounding lug in the rack/cabinet to the ground bar.
- T. RACK/CABINET BONDING OUTSIDE OF TELECOM ROOMS. Racks/cabinets outside of telecom rooms shall be bonded to the nearest electrical ground with a BC.
- U. LABELING: All labeling systems for telecommunications grounding infrastructure shall be in compliance with the ANSI/TIA-606-C standard. At a minimum, the following elements shall be labeled in the telecommunications grounding system:
 - 1. All TMGB or TGB, with a unique identifier located in the wall near the unit, not on the ground bar.
 - 2. All TBBs in the project with a unique identifier at each termination point of each TBB. The label in one side of the cable shall indicate the termination location of the other side of the cable.
 - 3. BC for rows of racks with a unique identifier at both ends of the cable
 - 4. BC for surge protectors with a unique identifier at both ends of the cable
- V. ADDITIONAL LABELING. All BCs boding rows of racks/cabinets and TBBs shall have additional to the identification marker a yellow printed wrap around tag installed close to the bonding point strap to the cable jacket with a flame retardant cable tie. This tag shall have the following

wording in green letters: "IF THIS CONNECTOR OR CABLE IS LOOSE OR MUST BE REMOVED, PLEASE CALL THE BUILDING TELECOMMUNICATIONS MANAGER".

3.2 AS BUILT DOCUMENTS AND CLOSE OUT INFORMATION

A. See specification section 270010 for as built and close out information requirements.

END OF SECTION 270526

SECTION 27 0528 RACEWAYS FOR TECHNOLOGY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. Section 260533 Raceway Systems, apply to work of this Section. Specifications described herein take precedence over Section 260533.
- C. Supplemental: Refer to the specification sections identified below for additional requirements, which are supplemented by this section.
 - 1. 270010 Technology General Provisions
 - 2. 270526 Grounding and Bonding for Telecommunications Systems

1.2 DESCRIPTION

- A. General: Furnish and install complete with all accessories a Pathways and Spaces infrastructure for supporting of Structured Cabling System (SCS) and housing of technology equipment. The goal of the project is to provide a reliable architecture of the building that shall serve as a support for transport of data, voice telephony, security and audio/visual cabling throughout the building from designated demarcation points to places located at various wall, floor, ceiling, column, room and other locations as indicated on the contract drawings and described herein.
- B. General: For pathways the system shall utilize a combination of conduit, cable tray and supports for vertical and horizontal cabling support. Pathways shall be provided and located as shown and in the quantities indicated on the drawings. Pathways shall terminate in rooms or closets using approved fasteners and termination hardware and bushings and shall be reamed to eliminate sharp edges. All Pathways shall be identified at all locations.
- C. All installers should anticipate that all products and installation procedures shall comply with the ANSI/TIA-569-E requirements at a minimum.
- D. General: Installation of the raceways for communications shall be a complete system including all supports and hangers as required per contract documents and manufacturer's installation guidelines.
- E. Support: All items shall be supported from the structural portion of the building. Supports and hangers shall be of a type approved by Underwriters' Laboratories. Wire shall not be used as a support. Boxes and conduit shall not be supported or fastened to ceiling suspension wires or to ceiling channels. Do not install any devices supported by ceiling tiles.
- F. Installation: The Installer shall layout and provide his work in advance of the laying of floors or walls, and shall provide all sleeves that may be required for openings through floors, walls, etc. Where plans call for conduit to be run exposed, provide all inserts and clamps for the supporting of conduit.

- G. Pull Strings: Provide pull strings in all raceways. Pull strings shall be nylon and shall be impervious to moisture. Pull strings installed in one (1) inch and smaller conduits shall have a tensile strength of not less than 30 lbs. Pull strings installed in conduits larger than one (1) inch shall have a tensile strength not less than 200 lbs.
- H. Directional boring might be required in the drawings or the installer might choose this method as the way to install underground conduit on this project. In either case, the installer shall comply with the requirements indicated here for directional boring.
- I. If at the time of bid and underground locate survey is not available, the installer shall include in the pricing the cost of this survey. No directional boring will be allowed without such survey being completed.

1.3 INSTALLER QUALIFICATIONS

- A. General: The installer selected for the Project must be BICSI certified installer and certified by the manufacturer for the products, adhere to the engineering, installation and testing procedures and utilize the authorized manufacturer components and distribution channels in provisioning the Project.
- B. General: The Installer directly responsible for this work shall be a "Pathways and Spaces for Structured Cabling System Installer (PS-SCS) " who is, and who has been, regularly engaged in the providing and installation of commercial and industrial pathways and spaces for telecommunications wiring systems of this type and size for at least the immediate past five years. Any sub-Installer who will assist the PS-SCS installer in performance of this work, shall have the same training and certification as the PS-SCS installer.
- C. Certification: The installer's Project Manager shall possess a current and in good standing BICSI Registered Communications Distribution Designer (RCDD) certificate. All shop drawings submitted by the installer shall bear the RCDD's seal.
- D. Experience: The Installer shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size. The Installer shall own and maintain tools and equipment necessary for successful installation and have personnel who are adequately trained in the use of such tools and equipment.

1.4 MATERIALS ALTERNATES AND SUBSTITUTIONS

A. General: Substitutions are allowed for all components of the systems under this specification sections as long as all requirements for substitutions indicated in specification section 270010 are followed.

1.5 SHOP DRAWINGS AND SUBMITTALS

- A. See additional requirements for shop drawings and submittals in specification section 270010.
- B. General: The PS-SCS installer shall provide no later than 30 days after contract award the following information:
 - 1. Proof of Installer's qualifications per paragraph 1.03.

- 2. Cut sheets of all products to be used for the project, highlighting in particular the precise product to be used in each case, when multiple devices are indicated in the cut sheet. At a minimum the following devices shall be submitted with this specification section:
 - a. Supporting devices (j-hooks) if allowed in the project. See part 3 of this specification.
 - b. Cable tray system with accessories
 - c. Runway cable tray system with accessories.
 - d. Plywood
 - e. Trough wall/floor firestop system
 - f. Innerduct
 - g. Detectable tape
 - h. Communications vaults
 - i. Conduit waterfalls
 - j. Fire stop system (for small penetrations)
- 3. Drawings indicating precise location and type of all support for cable tray or ladder tray systems in all areas where they will be used.
- 4. For all communication vaults, drawings shall be prepared indicating conduit penetrations on each side of each vault. Vaults shall be labeled to indicate their correct location in the site plan.
- 5. Pre-cast communications vaults shall be submitted with load calculations signed and sealed by a professional engineer.
- 6. For any directional boring runs, the installer shall provide a drawing indicating all underground locate surveys and the proposed routing of the conduit as well as proposed depth.

1.6 WORK EXTERNAL TO THE BUILDING

A. General: Any work external to the confines of this building as shown on the drawings shall be governed by provisions of this specification.

PART 2 - PRODUCTS

2.1 CONDUIT

A. All conduits as indicated in Section 26

2.2 TELECOMMUNICATIONS OUTLET BOX

- A. Telecommunication outlet electrical boxes shall be used to make terminations to limited energy systems described in Division 27 and Division 28 specifications. Telecommunications outlet boxes shall have the following specifications:
 - 1. Material: Steel, 0.6858mm. thickness (minimum) with galvanized zinc coating, 0.013mm. (minimum) thickness on both sides of bracket
 - 2. Construction: Cleanly punched knockouts, welded at 8 points (minimum) with softened edges (no sharp edges).
 - 3. Size (HXW): 4"X4"
 - 4. Depth: 2-7/8"
 - 5. Knock outs: At least one of this dimension: 1-1/4"
 - 6. Listing: UL or ETL

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 121505 Raceways for Technology Section 27 0528 - 3

- B. Telecommunications outlet electrical boxes shall be provided with the appropriate 1 gang or 2 gang rings selected for the proper thickness of the drywall in all areas. Standard telecommunications outlets shall use 1 gang ring, but design documents might indicate the use of 2 gang rings in selected areas.
- C. Knockouts in telecommunications outlet boxes shall not be field punched.
- D. Basis of design: Raco, Steel City, Randal Industries Inc,

2.3 HIGH DENSITY POLYETHYLENE (HDPE) PIPE

- A. HDPE pipe shall be used for all directional boring applications, or it can also be used for open trench applications. HDPE pipe shall comply with the following manufacturing standards:
 - 1. ASTM D 3035 Polyethylene (PE) Plastic Pipe (SDR) Based on Controlled Outside Diameter.
 - 2. ASTM D 2239 Polyethylene (PE) Plastic Pipe (SIDR) Based on Controlled Inside Diameter.
 - 3. ASTM F 2160 Solid wall High Density Polyethylene (HDPE) Conduit based on Controlled Outside Diameter (O.D.)
 - 4. NEMA TC-7 Smooth Wall Coilable Polyethylene Electrical Plastic Conduit.
- B. HDPE pipe shall be manufactured from a suitable thermoplastic polymer conforming to the minimum standard of PE334420E/C as defined in ASTM D3350. The resin properties shall meet or exceed the values listed below for HDPE pipe:

ASTM Test	Description	Values HDPE
D-1505	Density g/CM 3	0.941 - 0.955
D-1238	Melt Index, g/10 min Condition E	0.05 - 0.50
D- 638	Tensile strength at yield (psi)	3000 min.
D-1693	Environmental Stress Crack Resistance Condition B,F 20	96 min.
D-790	Flexural Modulus, MPa (PSI)	80,000 min.
D-746	Brittleness Temperature	-75°C

- C. Design selection: The HDPE pipe used in this project shall be Rib/Smooth Ribbed Interior and Smooth Exterior wall. Pipe shall be available in multiple colors, non lubricated and shall include a factory installed 1,800 lbs polyester pull tape. HDPE pipe walls shall be in compliance with SDR 7 ASTM D3035 specifications and shall have footage markings.
- D. Approved manufacturers: Carlon Industries or approved equal.

2.4 WIREWAYS

A. General: Wireway shall be sized as shown on drawings, NEMA 1, lay-in type. Wireway sides and bottom shall contain no knock-outs unless shown otherwise on the drawings. The Installer shall punch holes required. The cover shall be hinge type with quarter turn fasteners to hold

cover shut. Covers and bodies shall be 16 gauge steel. Wireway shall be as manufactured by Hoffman Engineering Company, Square "D" or Steel City.

2.5 SUPPORTING DEVICES

- A. Hangers: Hangers shall be made of durable materials suitable for the application involved. Where excessive corrosive conditions are encountered, hanger assemblies shall be protected after fabrication by galvanizing, or approved suitable preservative methods.
- B. Non-continuous cable supports (j-hooks) shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables; UL Listed.
- C. Non-continuous cable supports shall have flared edges to prevent damage while installing cables.
- D. Non-continuous cable supports sized 1 5/16" and larger shall have a cable retainer strap to provide containment of cables within the hanger. The cable retainer strap shall be removable and reusable and be suitable for use in air handling spaces.
- E. Non-continuous cable supports shall have an electro-galvanized or G60 finish and shall be rated for indoor use in non-corrosive environments.
- F. Stainless Steel non-continuous cable supports are intended for indoor and outdoor use in noncorrosive environments or where only mildly corrosive conditions apply.
- G. Anchoring: Insert anchors shall be installed on concrete or brick construction, with hex head machine screws. Recessed head screws shall be used in wood construction. An electric or hand drill shall be used for drilling holes for all inserts in concrete or similar construction. Installed inserts, brick, shall be near center of brick, not near edge or in joint. Drilled and tapped, and round head machine screws shall be used where steel members occur. All screws, bolts, washers, etc., used for supporting conduit or outlets shall be fabricated from rust-resisting metal, or accepted substitution. Gunpowder or lead set anchors are not permitted.
- H. Accessories: Non-continuous support systems shall be provided with the adequate mounting accessories depending on the location where the support will be installed, like beam clips, flange clips, C and Z purlin clips.
- I. Accepted manufactures; Erico or Panduit.

2.6 CABLE TRAY AND FITTINGS (BASKET TYPE)

- A. General Description: Basket type cable tray system is to be constructed of welded steel wire mesh with continuous safety edge wire lip. Provide mesh system permitting for continuous ventilation of cables and maximum heat dissipation.
- B. Materials: Carbon Steel: Cable management system to be manufactured from high strength minimum 6 gauge steel wires. Wire to be welded and bent prior to surface treatment.
- C. Finishes: Electro-plated zinc Galvanizing: Electrodeposited zinc coating applied to an average thickness of 0.7 mils to 0.8 mils.
- D. Cable tray dimensions: as shown on the drawings.

- E. Fittings: Cable tray fittings to be field manufactured from straight sections through use of hardware and instructions recommended by Manufacturer. Provide drop-off, 90° kits and tees as required using manufacturer fabricated products and installation guidelines.
- F. Installation: Cable tray system to be installed using splice connectors, and support components as recommended by the Manufacturer.
- G. Loading Cable tray system to be installed and supported per NEMA VE-2 and Manufacturer's suggested span load criteria.
- H. The cable tray system shall be UL listed and classified as a continuous bonded tray system providing a continuous grounding path. Cable tray system is required to be tested for grounding adequacy per NFPA 70B, Chapter 18 with a maximum allowable resistance of 1 ohm.
- I. Approved Manufacturers: Wiremold, Cablofil, Snake Tray, B-line, WBT or Chatsworth.

2.7 CABLE TRAY AND FITTINGS (LADDER TRAY TYPE)

- A. CABLE TRAY SECTIONS AND COMPONENTS
 - 1. General: Except as otherwise indicated, provide metal cable trays, of types, classes and sizes indicated; with splice plates, bolts, nuts and washers for connecting units. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards; and with the following additional construction features.
 - 2. Materials and Finish: Material and finish specifications for each cable tray type are as follows:
 - a. Aluminum: Straight section and fitting side rails and rungs shall be extruded from Aluminum Association Alloy 6063. All fabricated parts shall be made from Aluminum Association Alloy 5052.
- B. TYPE OF TRAY SYSTEM
 - Ladder type trays shall consist of two longitudinal members (side rails) with transverse members (rungs) welded to the side rails. Rungs shall be spaced 12 inches on center. Spacing in radiused fittings shall be 9 inches and measured at the center of the tray's width. Rungs shall have a minimum cable-bearing surface of 7/8 inch with radiused edges. No portion of the rungs shall protrude below the bottom plane of the side rails. Each rung must be capable of supporting the maximum cable load, with a safety factor of 1.5 and a 200 pound concentrated load when tested in accordance with NEMA VE-1, section 5.4.
 - 2. Ventilated trough type trays shall consist of two longitudinal members (side rails) with a corrugated bottom welded to the side rails. The peaks of the corrugated bottom shall have a minimum flat cable-bearing surface of 2-3/4 inches and shall be spaced 6 inches on center. To provide ventilation in the tray, the valleys of the corrugated bottom shall have 2-1/4 inch by 4 inch rectangular holes punched along the width of the bottom.
 - 3. Solid bottom trough type trays shall consist of two longitudinal members (side rails) with a corrugated bottom welded to the side rails. The peaks of the corrugated bottom shall have a minimum flat cable-bearing surface of 2-3/4 inch and shall be spaced 6 inches on center.
 - 4. Tray Sizes shall have 4 inch minimum usable load depth, or as noted on the drawing.
 - 5. Straight tray sections shall have side rails fabricated as I-Beams. All straight sections shall be supplied in standard 10 foot lengths, except where shorter lengths are permitted to facilitate tray assembly lengths as shown on drawings.
 - 6. Tray widths shall be as shown on drawings.
 - 7. All fittings must have a minimum radius as the width of the tray.

- 8. Splice plates shall be the bolted type made as indicated below for each tray type. The resistance of fixed splice connections between adjacent sections of tray shall not exceed .00033 ohms. Splice plate construction shall be such that a splice may be located anywhere within the support span without diminishing rated loading capacity of the cable tray.
 - a. Aluminum Tray Splice plates shall be made of 6063-T6 aluminum, using four square neck carriage bolts and serrated flange locknuts. Hardware shall be zinc plated in accordance with ASTM B633, SC1. If aluminum cable tray is to be used outdoors then hardware shall be Type 316 stainless.
 - b. Steel (including Pre-galvanized and Hot-dip galvanized) Splice plates shall be manufactured of high strength steel, meeting the minimum mechanical properties of ASTM A1011 HSLAS, Grade 50, Class 1. Each splice plate shall be attached with four ribbed neck carriage bolts with serrated flange locknuts. Hardware shall be zinc plated in accordance with ASTM B633 SC1 for pre-galvanized cable trays, or Chromium Zinc in accordance with ASTM F-1136-88 for hot-dip galvanized cable trays.
- 9. Splice plates shall be furnished with straight sections and fittings.
- 10. Cable Tray Supports: Shall be placed so that the support spans do not exceed maximum span indicated on drawings. Supports shall be constructed from 12 gauge steel formed shape channel members 1-5/8 inch by 1-5/8 inch with necessary hardware such as Trapeze Support Kits. Cable trays installed adjacent to walls shall be supported on wall mounted brackets. All types of supports shall be factory made supports supplied by the same manufacturer of the cable tray system as recommended for the type of cable tray selected.
- 11. Trapeze hangers supports shall be supported by 3/8 inch (minimum) diameter rods.
- 12. Barrier Strips: Shall be placed as specified on drawings and be fastened into the tray with self-drilling screws.
- 13. Accessories special accessories shall be furnished as required to protect, support, and install a cable tray system. Accessories shall consist of but are not limited to; section splice plates, expansion plates, blind-end plates, specially designed ladder dropouts, barriers, etc.
- C. LOADING CAPACITIES
 - Cable tray shall be capable of carrying a uniformly distributed load of 109 lbs. /ft. on a 12 foot support span with a safety factor of 1.5 when supported as a simple span and tested per NEMA VE1 Section 5.2. In addition to the uniformly distributed load the cable tray shall support a 200 lb. concentrated load at mid-point of span and centerline of tray. Load and safety factors specified are applicable to both side rails and rung capacities.
- D. Approved Manufacturers: B-line, Chatsworth or approved equal.

2.8 TUBULAR RUNWAY CABLE TRAY AND FITTINGS

- A. Materials: ASIM A36 steel bar.
- B. Finish: Baked Powder painted surface treatment using Polyester coating.
- C. Finish color: to match equipment cabinet finish color. See specification section 271000.
- D. Cable management tray width: as shown on the drawings.
- E. Fittings: Cable management fittings and hardware recommended by Manufacturer. Provide drop-off, 90° and tees as required for the equipment served and support of the cable. Provide at least one large radius drop off for each rack/cabinet in the project.
- F. Installation: Cable management system to be installed using support components as recommended by the Manufacturer.
- G. Loading: Cable management system to be installed and supported per Manufacturer's suggested span load criteria.
- H. Approved Manufacturers: B-line, GS Metals, Chatsworth.

2.9 PLYWOOD BOARDS IN TELECOMMUNICATION ROOMS

- A. Plywood Backboard: Backboards shall be installed in each TR and the MTR on walls to a height of 8' AFF or as shown on the drawings. Rooms shall have walls covered as shown on the drawings
- B. Acceptable options for plywood boards are:
 - 1. ³/₄" AC Grade fire rated plywood painted with two coats of fire retardant paint in both sides and on the edges.
 - 2. Pre-manufactured plywood system for telecommunications such as ReadySpec by Pathways and Spaces Inc.
- C. Other specifications:
 - 1. All imperfections and voids shall be filled, sealed and sanded prior to being primed and painted.
 - 2. Fire retardant coating shall be tested to UL723, "Test for surface burning characteristics of building materials."
 - 3. Paint color shall be grey, white or blue.
 - 4. Fire retardant plywood shall be clearly labeled with the name of the Backboard Manufacturer, UL Classification of the Fire Retardant Coating, NFPA 255 Coating Flame Spread Index Class and the APA Grade of the plywood.
 - 5. Plywood shall be installed with best side out.

2.10 THROUGH WALL/FLOOR FITTING FIRE STOP SYSTEM

- A. General. These devices covered under this specification are firestop devices for use in throughpenetration firestop systems, which are used to maintain the fire rating of the wall or floor, as well as to route and protect power and/or communications cable distribution for commercial, educational, healthcare, government, institutional, industrial and utility needs.
- B. Classification and use: The firestop device for use in through-penetration firestop systems shall have been examined and tested by Underwriters Laboratories Inc. to UL1479 (ASTM E 814) and bear the U.S. and Canadian UL Classification Mark. The device shall be classified for use in one-, two-, three-, and four-hour rated gypsum, concrete and block walls and provide a maximum L rating of 3.3 cfm. The device shall be classified for use in one-, two-, and three-hour rated concrete floors having a minimum 4 1/2" (114mm) thick reinforced lightweight or normal weight (100-150 pcf) (1600-2400 kg/m3). The devices shall also been tested by Underwriters Laboratories Inc. to UL2043 and determined to be suitable for use in air handling spaces.
- C. Materials:
 - 1. Box: The fire stop device box shall be constructed of 16 gage G90 steel.
 - 2. Intumescent block: The fire stop device intumescent block shall be constructed of a graphite base material with expansion starting at 375° F and an unrestrained expansion

between 6 to 12 times. The intumescent block shall be held securely by the box in order to prevent tampering and damage during installation.

- 3. Adjustable doors: the fire stop device shall have doors or other system which can be adjusted to prevent materials from penetrating the device if the device is empty or completely full. The doors shall be constructed of 16 gage G90 steel with no. 10-32 screws use to adjust opening size.
- 4. Heat shield: For retrofit applications where an existing in-wall conduit extends out from the wall more than 7/8" [22mm], a UL listed Heat Shield must be used in order to maintain UL Fire Classification. The firestop device is then installed onto the heat shield
- 5. Split conduit and wall plate: For retrofit applications where no conduit is installed in the wall to protect existing cables, a split conduit assembly should be used to protect cables. After installing the split conduit within the wall, a wall plate should be installed to cover any irregularly shaped hole cut in the wall. The firestop device is then installed onto the conduit.
- D. Retrofit: For retrofit applications the unit shall be a split case system that allows the unit to be installed over existing cables.
- E. Sizes: the fire stop device shall be available for two (2) inch and four (4) inch trade size EMT conduit.
- F. Finish: the fire stop device shall be available in safety yellow or orange powder coat, custom colors and an unpainted galvanized finish.
- G. Design selection: Hilti, STI EZpath or approved equal

2.11 INNERDUCT (REGULAR)

- A. Flexible raceway system also referenced in the design documents as regular innerduct or innerduct shall be provided in locations indicated in design drawings. The innerduct type shall be selected according to the environment where it will be installed, use HDPE innerduct only outdoors, use plenum or riser rated innerduct indoors. The installer is responsible for determining the proper selecting of the innerduct when used in air handling spaces. If at the time of bidding the installer is not sure what kind of environment is present in the project, the installer shall price plenum rated materials.
- B. For plenum rated applications, the specifications of the innerduct shall be:
 - 1. Material: White or orange Kynar PVDF Resin, a fluoropolymer compound.
 - 2. Listing: Innerduct shall be listed to UL 2024, listing shall be printed in the product.
 - 3. Marking: Footage shall be sequentially marked.
 - 4. Configuration: corrugated type.
 - 5. Pull line: built in 900 lb rated tape.
 - 6. Size: Shall be available in $\frac{3}{4}$ " through 2" diameters.
- C. For riser rated applications, the specifications of the innerduct shall be:
 - 1. Material: Orange polyvinyl chloride (PVC).
 - 2. Listing: Innerduct shall be listed to UL 2024, listing shall be printed in the product.
 - 3. Marking: Footage shall be sequentially marked.
 - 4. Configuration: corrugated type.
 - 5. Pull line: built in 900 lb rated tape.
 - 6. Size: Shall be available in $\frac{3}{4}$ " through 2" diameters.
- D. For outdoor applications, the specifications of the innerduct shall be:
 1. Material: High Density Polyethylene (HDPE).

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

Project No. 121505 Raceways for Technology Section 27 0528 - 9

- 2. Listing: None.
- 3. Marking: Footage shall be sequentially marked.
- 4. Configuration: corrugated type.
- 5. Pull line: built in 1,800 lb rated tape.
- 6. Size: Shall be available in $\frac{3}{4}$ " through 2" diameters.
- E. All inner ducts shall be provided with couplings and accessories suitable for the environment where they will be installed.
- F. Design selection: products by Carlon or approved equal.

2.12 INNERDUCT (FABRIC TYPE)

- A. When indicated in the design drawings, high capacity innerduct made of fabric shall be used inside telecommunication raceways to facilitate the pulling of telecommunication wires in those raceways. The fabric type Innerduct (also referenced as textile innerduct) shall have the following specifications:
 - 1. Material: White Polyester and Nylon resin polymer
 - 2. Standard Outdoor Textile Innerduct: Micro (33mm), 2-inch, 3-inch and 4-inch single or multi-cell polyester/nylon textile innerduct containing 1250lb polyester flat woven pull tape.
 - 3. Indoor Textile Innerduct (Riser-listed): Micro (33mm), 2-inch, 3-inch and 4-inch single or multi-cell nylon textile innerduct containing 1250lb polyester flat woven pull tape which meets UL2024A for flame propagation and smoke density values for general applications.
 - 4. Plenum-Listed Textile Innerduct: Micro (33mm), 2-inch and 3-inch single or multi-cell nylon textile innerduct containing 200lb nylon-resin flat woven pull tape which meets UL2024A for flame propagation and smoke density values for use in air handling spaces.
- B. The installer is responsible for determining the proper selecting of the innerduct when used in air handling spaces. If at the time of bidding the installer is not sure what kind of environment is present in the project, the installer shall price plenum rated materials.
- C. Design selection: Products manufacturer by The Maxcell Group or approved equal. Approved equal shall be only of the fabric type innerduct.

2.13 DETECTABLE TAPE

- A. A detectable tape shall be installed above all underground conduit at a minimum depth of 18" or as shown on the drawings. The detectable warning tapes shall be constructed with a solid aluminum foil core with a minimum thickness of 5 mils and 3" wide. The detectable warning shall have printed diagonal warning stripes conform to APWA color recommendations and bold, black legends identify what type of utility line is buried below. All detectable tapes used for this shall be labeled "fiber optics buried below".
- B. Design selection: Detectable tape from Carlon, Stranco, Ind., Terra Tape or approved equal.

2.14 COMMUNICATIONS VAULT (POLYMER CONCRETE)

- A. In ground communication boxes also referenced in this document as communications vaults (polymer concrete) shall have the following specifications:
 - 1. Construction Material: Precast Polymer Concrete.

- 2. Listing: UL listed enclosure, tested to ANSI/SCTE 77
- 3. Box vertical design load: 22,500 lbs.
- 4. Box vertical test load: 33,750 lbs.
- 5. Box lateral design load: 800 lbs/sq. ft.
- 6. Box lateral test load: 1,200 lbs/sq. ft.
- 7. Box dimensions: as indicated in design drawings.
- 8. Box bottom: open bottom
- 9. Holes for conduit: holes for conduit shall be cut at the factory and shall not cover more than 25% of the side of the enclosure. All sides of the box shall have holes for conduits, even though conduits might not be shown for all sides in the floor plans. No less than two holes for standard 4" conduit shall be at all sides. All unused holes shall be plug with plastic caps.
- 10. Cover ANSI TIER: 22
- 11. Cover logo: "Communications"
- 12. Cover screws: two (2) tamper resistant penta head screws
- 13. Cover accessories: two (2) 7" long cover hooks made of electroplated steel.
- B. Design selection: Hubell Quazite PG style box with HH series cover and accessories or approved equal. Approved equals shall comply with all specifications listed above including construction material.

2.15 COMMUNICATIONS VAULT (PRECAST CONCRETE)

- A. In ground communication boxes also referenced in this document as communications vaults (precast concrete) shall have the following specifications:
 - 1. Construction Material: concrete 5000 psi @ 28 days
 - 2. Rebar: ASTM A 615 grade 60 rebar
 - 3. Mesh: Welded wire fabric ASTM A185 grade 65
 - 4. Size: As indicated in design drawings
 - 5. Design: comply with local building code for reinforced concrete
 - 6. Loads: Dead load: concrete 150 PCF
 - Earth cover 120 PCF

Lateral Earth pressure on walls: Equivalent fluid pressure above water table + 36 PSF per foot of depth. Equivalent pressure below water table + 81.4 PSF per foot of depth.

- 7. Live load: AASHTO HS20-44. 32,000 lbs. rear axle loading.
- B. The cover and frame for the communications vault shall have the following specifications:
 - 1. Style: Hatch type [galvanized cover] [concrete lid] [concrete lid with ring and cover].
 - 2. Cover design (for hatch type or galvanized cover): Hot dip galvanized after fabrication built to an H20 rating for non roadway applications with dual doors.
 - 3. Cover design (for concrete lid with ring): 30" diameter cast or ductile iron, built to an H20 rating up to 150 KIO.
 - 4. Lettering: Covers shall be label as "Telecommunications"
- C. All communications vault shall be provided with the following accessories:
 - 1. Embedded lifters made of galvanized steel
 - 2. All communications vaults with a concrete lid and ring shall be provided with a grade ring or riser made of concrete to bring the cover up to grade level. Precast concrete grade rings and cones shall comply with ASTM C 478, except that the wall thickness shall be 6 inches minimum. Provide interlocking keyways on rings and cones. Provide cones with cast in place inserts for the vault frame.
 - 3. Embedded pulling irons made or carbon steel galvanized.

- 4. Two lengths of embedded unistrut (galvanized) for bolting equipment on 2 opposite walls of the vault.
- D. Precast vault construction shall be in the form of monolithic walls or horizontal wall sections. Do not use panel walls.
- E. Minimum wall thickness shall be 6 inches. Design knockout wall panels to accommodate loading pressures defined above.
- F. Design and construct vaults to be watertight when subjected to groundwater over the entire height of the vault.
- G. Provide openings in precast vaults for piping and access. Provide cast in place inserts in the roof slab and end walls at the locations as shown on the Drawings. No field coring of openings is allowed.
- H. When communications vault are made of different sections, they shall be sealed and bonded with a double layer of plastic sealing compound and make watertight. Plastic sealing compound shall comply with Federal Specification SS-S-00210. Fill with mortar all recesses, lifting inserts, or other cavities not filled with plastic sealing compound. Mortar shall comply with ASTM C 387, Type S.

2.16 CONDUIT WATERFALLS

- A. All 4" EMT terminations with communication cable entering/exiting the conduit from a cable tray (or tubular runway) system and the vertical separation between raceways is larger than 7" shall be fitted with a device to control the bend radius of the communication cable to a minimum of a 4" radius. The device to control the bend radius shall be called a conduit waterfall and must comply with all National Electrical Code requirements and TIA/EIA Standards. In addition, the product must be RoHS compliant to meet environmental requirements, be UL 94V-0 approved to reduce the spread of flame, and be approved by UL for use in air handling spaces. The device to provide bend radius control must support a static load of 40 lbs. (177.9 N) and have a fastening device that allows for incremental adjustments to conform to variances in conduit diameters.
- B. Device quantities are not indicated in the drawings but the PS-SCS shall use all 4" conduits and sleeves indicated in the drawings to estimate the quantities of waterfalls to be used in the project.
- C. Basis of design: Panduit CWF 400 or approved equal.

2.17 FIRE STOP SYSTEMS (FOR SMALL PENETRATIONS)

- A. General: Fire stop system shall be selected by the PS-SCS installer as to comply with the following requirements:
 - 1. Selected system shall be UL listed for the condition on which it will be installed. These conditions include: wall/slab type (masonry, drywall, etc), hour rating, and accessibility type.
- B. Acceptable systems: caulk based products or firestop grommets by STI or equal.

2.18 EXPANSION FITTINGS

- A. Installation: Provide expansion fittings in each conduit run wherever it crosses an expansion joint. Install the fitting on one side of the joint with its sliding sleeve end flush with joint, and with a length of bonding jumper in expansion equal to at least three times the normal width of joints.
- B. Location: Provide expansion fittings in each conduit run which is mechanically attached to separate structures to relieve strain caused by shift on one structure in relation to the other.
- C. Length: Provide expansion fittings in straight conduit runs above ground which are more than one hundred (100) feet long.
- D. Flex conduit is not allowed to be used as expansion fittings.
- E. Design drawings do not show symbols for expansion fitting. The installer shall look at the structural and architectural drawings for locations of expansion joints to determine the quantities of fittings required for the job.

PART 3 - EXECUTION

3.1 INSTALLATION PRACTICES

A. See additional requirements indicated in part 3 of specification section 270010.

3.2 INDOOR CONDUITS BELOW GRADE AND ABOVE GRADE

- A. BEND RADIUS. Conduits shall utilize long radius sweeps at all 90 degree transitions. The inside radius of a bend in conduit shall be at least six (6) times the internal diameter. When the conduit size is greater than two (2) inches, the inside radius shall be at least ten (10) times the internal diameter of the conduit. For fiber optic cable, the inside radius of a bend shall always be at least ten (10) times the internal diameter of the conduit.
- B. ENCLOSURES USED AS CONDUIT BENDS. Enclosures such as junction boxes, handholes or communications vaults shall not be used to change direction of conduits, unless the enclosures are large enough to preserve the bend radius of the conduit as indicated in the point above. As an example, a junction box with 4" conduits entering in two adjacent sides of the enclosure should preserve a minimum of 40" radius between the closest conduits in the adjacent sides of the enclosure. It is required, that if the enclosure sizes don't meet this criteria, the conduit bends shall be done before entering the enclosure.
- C. ENCLOSURES FOR STRAIGHT PULLS. Enclosures such as junction boxes, handholes or communications vaults used in straight pulls, shall have a minimum length to allow for proper cable pulling. Enclosures with terminating conduits from 2" to 3" in size shall use enclosures with a minimum length of 24". Enclosures with terminating conduits of 4" in size shall use enclosures with a minimum length of 36". It is acceptable to use metallic wireways as junction boxes for straight pulls as long as they are installed with the cover accessible to the end user.
- D. MAXIMUM DISTANCE BETWEEN JBOXES. For indoor installation no section of conduit shall be longer than one hundred (100) ft or contain more than two (2) 90 degree bends between pull points or pull boxes are required. For outdoor installation no section of conduit shall be longer

than six hundred (600) ft. or contain more than two 90 degree bends between pull points or pull boxes are required.

- E. LABELING. All indoor conduits 2" or larger shall be labeled at both ends when these conduit runs are continuous between two rooms and going through multiple walls or slabs. Labeling materials shall be as indicated in specification section 270010. Conduit sleeves 2" or larger penetrating just one wall is not required to be labeled.
- F. PULL STRINGS; All conduits for technology systems shall be installed with pull strings.

3.3 UNDERGROUND TELECOMMUNICATIONS DUCT LINES

- A. Description: Underground duct lines shall be of individual conduits. Conduits shall be encased in concrete where indicated on the plan drawings and duct bank sections. The conduit shall be of plastic, PVC Schedule 40, unless indicated or specified otherwise. The conduit used shall not be smaller than four (4) inches in diameter, inside, unless otherwise noted on the drawings.
- B. Duct lines shall have a continuous slope downward toward communication vaults and away from buildings with a pitch of not less than 0.125 inches per foot. Changes in direction of runs exceeding a total of ten (10) degrees either vertical or horizontal shall be accomplished by long sweep bends having a minimum radius of curvature of twenty five (25) feet, except that manufactured bends may be made up on one or more curved or straightened sections or combinations thereof. Manufactured bends shall have a minimum radius of forty eight (48) inches.
- C. Conduits. Conduits shall terminate in end-bells where duct lines enter manholes or communications vaults. Provide four (4) to six (6) inch reducers as required. Separators shall be of pre-cast concrete, high impact polystyrene, steel or any combination of these. The joints of the conduits shall be staggered by rows so as to provide a duct line having the maximum strength. During construction partially complete duct lines shall be protected from the entrance of debris, such as mud, sand and dirt by means of suitable conduit plugs. As the duct line is completed, a testing mandrel not less than 13 inches long with a diameter 1/4 inch less than the size of the stiff bristles shall be drawn through until the conduit is clear of all particles of earth, sand or gravel; conduit plug shall then be immediately installed.
- D. Conduit. Plastic conduit, fittings and joints shall not have been stored in the sun or weather, in any excessively heated space, or unevenly supported during storage. Use and installation shall be in accordance with the National Electrical Code requirements for the installation of non-metallic rigid conduit. Plastic conduit shall be protected against the direct rays of the sun prior to installation. Conduit shall be Carlon Type EB, Queen City Plastics, or accepted substitution. Conduit shall be U.L. listed and conform to NEMA Standard TC6 1972.
- E. Trench: Trenches for duct banks shall be completely dry before setting conduits or pouring concrete. Well pointing as required shall be provided if necessary to keep trench dry.
- F. Excavation: Backfilling shall be in layers not more than eight (8) inches deep, and shall be thoroughly tamped. The first layer shall be earth or sand, free from particles that would be retained on a 1/4 inch sieve. The succeeding layers shall be excavated material having stones no larger than would pass through a four (4) inch ring. The backfill shall be level with adjacent surface, except that in sodded or paved areas, a space equal to the thickness of the sod or paving shall be left.

- G. Finish: The surface disturbed during the installation of duct shall be restored to its original elevation and condition if not refinished in connection with site work.
- H. Plugging: All unused conduit openings shall be plugged or capped with a suitable device designed for the purpose; caulking compound shall not be used for plugging conduit openings.
- I. Stubs: Spare conduit stubs shall be capped and marked in the field and accurately dimensioned on the as-built drawings.
- J. Spacers: All conduit run underground, or stubbed above floor shall be separated with plastic interlocking spacers manufactured specifically for this purpose, or shall be strapped to Kindorf channel supported by conduit driven into ground or tied to steel.
- K. Minimum burial depth: All underground raceways (with exception of raceways installed under floor slab) shall be installed in accordance with Section 300 5 of the NEC except that the minimum cover for any conduit or duct bank shall be two (2) feet, unless otherwise indicated.
- L. Directional boring. For all applications requiring directional boring the following installation practices shall be followed.
 - 1. The installer shall select the directional boring equipment based on the length of the pulls, soil conditions, pipe size and pipe quantities.
 - 2. When multiple pipes are run, each pipe shall be a different color.
 - 3. Any pipe run less than 1,500 ft, shall be run as a single pull without splices.
 - 4. Any splices done to HDPE pipes shall be done with manufacturer's approved methods.

3.4 INSTALLATION OF COMMUNICATIONS VAULTS

- A. Excavating and backfilling for vaults. Perform earthwork as specified in Division 2. Provide 6inch minimum thickness 3/4-inch crushed rock over the full width of the vault base and extend 12 inches beyond the edges of the vault. After repairing the waterproofing, backfill and compact around the vault with structural backfill material. Excavated material may be used for structural backfill provided it conforms to the Standard Specifications for structural backfill material.
- B. Installing vaults and risers. Set each concrete vault section or riser plumb on a double layer bed of sealant at least 1/2-inch thick to make a watertight joint with the preceding unit. Point the inside joint and wipe off the excess sealant.
- C. Waterproofing. Waterproofing shall be factory applied to all exterior surfaces of vaults and risers. This includes the bottom of the vault to be coated as an exterior surface. Apply two coats at a rate of 65 square feet per gallon per coat. Prior to backfilling, field apply waterproofing material on joints and damaged surfaces. Protect coating from damage during backfilling and compacting.

3.5 CUTTING AND PATCHING

A. Core Drilling: The installer shall be responsible for all core drilling as required for work under this section, but in no case shall the installer cut into or weld onto any structural element of the project without the written approval of the A&E. Any post tension slabs or slabs with embedded electrical raceways shall be X-rayed prior to coring by the installer.

- B. Cutting and Patching: All cutting, rough patching and finish patching shall be provided as specified in the contract documents. All cutting and patching shall be performed in a neat and workmanlike manner.
- C. Openings and Sleeves: Locate all openings required for work performed under this section. Provide sleeves, guards or other accepted methods to allow passage of items installed under this section.
- D. Roof Penetration: All roof penetrations for raceways part of technology systems shall be approved by A&E prior to executing this work. All roof penetrations shall be as accepted by the roof manufacturer.

3.6 IDENTIFICATION OF BOXES

A. Tags: During installation of pull strings all pull strings shall be marked with waterproof vinyl tags indicating where the opposite end may be found.

3.7 BLANK PLATES

A. Plates: Unless otherwise noted all unused outlet boxes shall receive blank plates matching the finish of plates for electrical devices in the same room.

3.8 RACEWAY INSTALLATION

- A. SUPPORT. All raceways shall be run in a neat and workmanlike manner and shall be properly supported and in accordance with the latest edition of the NEC code and BICSI guidelines. Supporting conduit and boxes with wire is not acceptable. Exposed raceways where allowed, shall be supported with clamp fasteners with toggle bolt on hollow walls, and with no lead expansion shields on masonry. All conduits shall be securely fastened in place with at least one support per eight foot section. Support within one foot of changes in direction. All required hangers, supports and fastenings shall be provided at each elbow and at no more than one foot from the end of each straight run terminating at a box or cabinet. The use of perforated iron for supporting conduits shall not be permitted. The required strength of the supporting equipment and size and type of anchors shall be based on the combined weight of conduit, hanger and cables. Horizontal and vertical conduit runs may be supported by one-hole malleable straps, clamp-backs, or other accepted devices with suitable bolts, expansion shields (where needed) or beam-clamps for mounting to building structure or special brackets.
- B. HANGER INSTALLATION. Where two (2) or more conduits one (1) inch or larger run parallel, trapeze hangers may be used consisting of concrete inserts, threaded solid rods, washers, nuts and galvanized "L" angle iron, or Unistrut cross members. These conduits shall be individually fastened to the cross member of every other trapeze hanger with galvanized cast one hole straps, clamp backs, bolted with proper size cadmium machine bolts, washers and nuts. If adjustable trapeze hangers are used to support groups of parallel conduits, U-bolt type clamps shall be used at the end of a conduit run and at each elbow. J-bolts, or approved clamps, shall be installed on each third intermediate trapeze hanger to fasten each conduit.
- C. NON-CONTINUOUS CABLE SUPPORTS INSTALLATION. When j-hooks are allowed in the project by this specification (See USE OF CONDUIT FOR DIFFERENT SYSTEMS) non-continuous cable supports (j-hooks) shall be installed only as recommended by manufacturer not exceeding the load ratings of the devices. Install non-continuous cable supports in spans no

longer than 4'. Whenever there are changes in elevation additional supports shall be required to avoid having stress on cable or sharp bends.

- D. PENETRATIONS IN FIRE RATED PARTITIONS. Installation of electrical boxes or equipment backboxes in fire rated walls and smoke barriers shall follow the following requirements:
 - 1. Electrical boxes and or technology system backboxes can be installed in 1 or 2 hour rated walls as long as all requirements indicated in the proper Building Code, National Electrical Code and nationally recognized testing laboratories are met for this type of installation.
 - 2. As a summary, some of the requirements indicated by the codes listed above are:
 - a. Boxes shall be metallic or listed for that purpose
 - b. The area of the boxes shall not exceed 16 square inches, provided the aggregate are of the openings through the membrane does not exceed 100 square inches in any 100 square feet of wall area.
 - c. The spacing between the wall membrane and the box shall not exceed 1/8 of an inch.
 - d. Boxes on opposite sides of the walls shall be separated by no less than 24 inches, or boxes shall be covered by listed putty pads, or a listed material and method used.
 - 3. Electrical boxes or technology systems backboxes shall not be installed in a 3 or 4 hour fire rated rated walls.
- E. ROUTING: Conduits shall be run parallel to building walls wherever possible, exposed or concealed as specified, and shall be grouped in workmanlike fashion. Crisscrossing of conduits shall be minimized.
- F. PROTECTION DURING CONSTRUCTION. All raceway runs, whether terminated in boxes or not, shall be capped during the course of construction until wires are pulled in and covers are in place. No conductors shall be pulled into raceways until the raceway system is clean and complete.
- G. PROTECTIVE BUSHINGS: All un-terminated conduits shall have an insulated protective bushing to avoid cable damage at the edge of the conduit.
- H. AVOIDING EMI: To avoid EMI for Telecommunications cabling and/or conduit containing cabling, all raceways shall provide clearances of at least four (4) feet (1.2 meters) from motors or transformers; one (1) foot (0.3 meter) from conduit and cables used for electrical-power distribution; and five (5) inches (12 centimeters) from fluorescent lighting. Raceways shall cross perpendicular to fluorescent lighting and electrical-power cables and conduits. The Installer shall not place any raceway alongside power lines
- I. COORDINATION. All raceways shall be kept clear of mechanical equipment and plumbing fixtures to facilitate future repair or replacement of said fixtures without disturbing wiring. Except where it is necessary for control purposes, all raceways shall be kept away from items producing heat.
- J. MASONARY INSTALLATION. All raceway runs in masonry shall be installed at the same time as the masonry so that no face cutting is required, except to accommodate boxes.
- K. USE OF CONDUIT IN DIFFERENT AREAS. When low voltage cables (any technology system) have to be run above ground in a space with no type of accessible ceiling (interior or exterior), all cable runs shall be in conduit completely, continuing the raceways all the way to the nearest accessible ceiling (in the direction of the telecom closet) or grouping the raceways into a single larger diameter conduit with the same or larger cross sectional area than the sum of all the conduits coming into it. The use of j-hooks to support low voltage cables in areas with no ceiling

or inaccessible ceiling (e.g. hard ceilings) shall not be allowed. This type of condition is usually not indicated in the drawings because design drawings don't show conduits smaller than 2", nevertheless it shall be provided as indicated herein.

- L. USE OF CONDUIT FOR DIFFERENT SYSTEMS: The following paragraphs indicate the design intent for raceways system for all technology systems.
 - 1. For all systems under division 27: Conduit stub up from the outlet to the nearest accessible ceiling, non-continuous support system to the nearest cable tray system to the telecommunications room
 - 2. For all systems under Division 28 with the exception of Fire Alarm and Security Voice Communication system: Conduit stub up from the outlet to the nearest accessible ceiling, non-continuous support system to the nearest cable tray to the telecommunications room.
 - 3. Non-continuous support systems (J-hooks) are allowed in this project as a horizontal support system for cables above ceilings. J-hooks shall not replace the cable tray system shown in the drawings.

3.9 CABLE TRAY INSTALLATION

- A. Inspection: Examine area for clearances, to allow proper installation of the tray according to the routing indicated on the drawings. Check existing building steel and other supporting structures to establish the type of tray hangers to be used and at the proper spans.
- B. Installation Criteria: Installation shall be in accordance with equipment manufacturer's instructions, and with recognized industry practices to ensure that cable tray equipment comply with requirements of NEC and applicable portions of NFPA 70B. Reference NEMA-VE2 for general cable tray installation guidelines
- C. Support: Cable tray support shall be by means of welded angle brackets to structural components, brackets shall be as manufactured by the Cable tray manufacturer. Complete straight section of cable tray shall have at least 1 support at a ¼ of the length of the section. Additional supports are required at tray ends, offsets, bends and changes of elevation.
- D. Grounding: All conduits terminating within 12 inches of a cable tray shall be bonded with a grounded in accordance with the National Electric Code.
- E. Coordination: Wherever possible, install horizontal cable trays above water and steam piping. Coordinate installation of tray with other trades for clearances, to avoid conflicts. A minimum of 300 mm (12 in) access headroom shall be provided and maintained above the cable tray system or cable runway. A minimum of 150 mm (6 in) access headroom shall be provided and maintained at both sides (one side if tray is supported at the wall. Care shall be taken to ensure that other building components (e.g., air conditioning ducts, pipes, structural elements) do not restrict access. The cable tray must be installed with at least 75mm (3 in) of clear vertical space above the ceiling tiles and support channels (T-bars) to ensure accessibility. When crossing other building components with the cable tray or runway the above specified clearances shall be maintained.

3.10 RUNWAY CABLE TRAY OR CABLE TRAY SYSTEM INSTALLATION INSIDE T.R.

A. GENERAL. Runway cable tray systems or cable tray systems being installed inside telecom rooms shall be installed following manufacturer's recommendations for installation and all the following requirements indicated in this specification section.

- B. SUPPORT LOCATIONS. Supports shall be provided as recommended by the manufacturer, but as a minimum supports shall be located as follows:
 - 1. Before each 90 deg turn.
 - 2. No continuous section shall have more than 3ft of span without a support.
 - 3. At each 2-post rack or 4-post rack
 - 4. At each change in elevation
- C. SUPPORT TYPE. When the runway/cable tray is to be installed against the wall, the only support type to be used is a wall bracket supporting from the bottom of the tray. For sections of runway/cable tray to be installed over racks, the preferred support system is to the racks themselves. Trapeze style support brackets shall only be used when no other method of support is possible. Center hung support systems shall never be used.
- D. VERTICAL SECTIONS. Runway/cable tray system shall be installed continuously vertically in all telecommunications rooms in the project from sleeves coming from the ground (or floor below) to the sleeves going to the floor above, whether or not indicated in the drawings. The runway/cable tray installed shall have the same width as the total width of the sleeves coming into the telecommunications room, although multiple sections installed together are acceptable. If the sleeves from the floor below to the floor above don't line up in a straight line, two vertical sections are accepted, one to the horizontal runway cable tray and one from the horizontal runway cable tray to the sleeves above. Runway/cable trays installed vertically shall have supports to the floor, wall and slab above.
- E. VERTICAL SECTIONS TO CONDUITS. Runway/cable tray shall be installed continuously vertically in all telecom rooms in the project when conduits larger than 2" terminate in the telecom room at the height higher than 4' from the highest vertical runway/cable tray installed above the racks. The runway/cable tray installed shall have the same width as the total width of the sleeves coming into the telecommunications room, although multiple sections installed together are acceptable. The length of these sections of runway shall be the complete length from the vertical runway/cable tray to the conduits stubbing in the room. The idea for these runway/cable tray sections is to provide support for the cables coming out of the conduit to the vertical runways/cable trays. Runways/cable tray installed vertically shall a standoff of no less than 1" from the wall to allow for proper lacing of the cables.
- F. CABLE DROP OUT. At each rack or cabinet that has runway/cable tray system running on top of it, a cable dropout shall be installed to protect the bend radii of the cable. This dropout accessory shall have a bend radius of no less than 4".
- G. BONDING. Any two continuous sections of runway/cable tray system shall be bonded together with a #1 bonding jumper (600A) 15" long. All bonding jumpers shall be made of steel with yellow, zinc-dichromate finish. All fasteners shall be made of steel with zinc-plated finish. See specification section 270526 for more details.
- H. PROTECTIVE END CAPS. All end sections of runway cable tray sections shall be protected with plastic protective end caps.

3.11 INSTALLATION OF INNERDUCT

- A. PROTECTION. Protect products from the effects of moisture, UV exposure, corrosion and physical damage during construction.
- B. SUPPORT. When inner duct is laid on a cable tray, it shall be strapped to cable tray with nylon ty-wraps at periodic intervals of no less than 4 ft.

- C. COLOR CODING. When multiple inner duct are in a single conduit, and innerduct are of the same size, they shall be different colors for identification or have different color electrical taped wrapped on the ends to identify them at the end of each conduit.
- D. USE OF INNERDUCT. Any continuous conduit installed below grade or above grade with a size of 3 inches or larger shall have innerducts inside, along the complete conduit run. In particular for 4" conduits, a minimum of three (3) innerducts shall be installed inside each conduit, regardless if cables are being run as part of this project or not. One of those innerducts shall be a 1-1/2", the other two innerducts shall be 1" innerducts.

3.12 USE OF FIRE STOP SYSTEMS

- A. CABLE TRAYS. Cable trays or tubular runways shall not be allowed to pass continuously through a fire rated partition or smoke barrier. The following guidelines shall be followed to seal those openings:
 - 1. Use only UL listed methods per the wall rating.
 - 2. Pillow type or brick type systems are not allowed.
 - 3. For cable trays 12" in width or less, use only 4" through wall fitting fire stop systems. The quantity of systems shall be dependent on the cross sectional area of the cable tray system installed. The total cross sectional area of the fittings installed shall match the cross sectional area of the cable tray system installed. As an example, a 12" wide cable tray, 4" high shall have four (4) through wall fitting fire stop systems regardless of how many cables are being run on the cable tray system.
 - 4. For cable trays wider than 12", use a combination of 4" EMT sleeves with fire caulk based systems and through wall fittings fire stop system. The total cross sectional area of the sleeves/fittings installed shall match the cross sectional area of the cable tray system. To determine the quantity of sleeves and fittings for each case, the following method shall be used. All cables installed as part of this contract can be run through 4" sleeves with fire caulking and remaining sleeves, but no less than 1/2 of all sleeves required shall be through wall fitting fire stop systems. So, as an example an 18" wide, 4" high cable tray, requires a total of 6 4" sleeves. Out of those six, there shall be no less than three 4" through wall fitting fire stop systems with no cables installed inside and no more than three 4" sleeves with fire caulking with all cables installed as part of this contract, regardless of how many cables are being run on the cable tray.
- B. SMALL CONDUIT SLEEVES. When J-hooks are allowed in the project and small cable bundles are required to go through a rated partition, it is acceptable to use fire caulk. A small bundle of cables is defined as a bundle than can fit on a sleeve that is 1.5" in size or less. For larger bundles, requiring 2" sleeves or larger, use only through wall fitting fire stop systems.
- C. CONTINUOUS CONDUITS RUNS. Continuous horizontal conduit runs or conduit entering a rated telecom room shall be fire stop with caulk based fire stop systems, regardless of the size of the conduit.
- D. ELECTRICAL BOXES. Installation of electrical boxes or equipment backboxes in fire rated walls and smoke barriers shall follow the following requirements:
 - 1. Electrical boxes and or technology system backboxes can be installed in 1 or 2 hour rated walls as long as all requirements indicated in the proper Building Code, National Electrical Code and nationally recognized testing laboratories are met for this type of installation.
 - 2. As a summary, some of the requirements indicated by the codes listed above are:
 - a. Boxes shall be metallic or listed for that purpose

- b. The area of the boxes shall not exceed 16 square inches, provided the aggregate are of the openings through the membrane does not exceed 100 square inches in any 100 square feet of wall area.
- c. The spacing between the wall membrane and the box shall not exceed 1/8 of an inch.
- d. Boxes on opposite sides of the walls shall be separated by no less than 24 inches, or boxes shall be covered by listed putty pads, or a listed material and method used.
- 3. Electrical boxes or technology systems backboxes shall not be installed in a 3 or 4 hour fire rated rated walls.
- E. VERTICAL SLEEVES. Fire stop system shall be used for all 4" vertical sleeves used inside telecom rooms to run from one floor to the next. Half the sleeves indicated in the design drawings shall be protected with caulk based fire stop systems and the other half with through floor fittings fire stop systems.

3.13 AS BUILT DOCUMENTS AND CLOSE OUT INFORMATION

A. See specification section 270010 for as built documents and close out information these requirements.

END OF SECTION 270528

SECTION 27 0548 SEISMIC CONTROLS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Restraints rigid type.
 - 2. Restraints cable type.
 - 3. Restraint accessories.
 - 4. Post-installed concrete anchors.
 - 5. Concrete inserts.

1.3 **DEFINITIONS**

A. Designated Seismic System: A communications system component that requires design in accordance with ASCE/SEI 7, Ch. 13 and for which the Component Importance Factor is greater than 1.0.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated load capacity for each seismic and wind-load restraint device.
 - 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic and wind-load restraint component used.
 - 3. Annotate types and sizes of seismic restraints and accessories, complete with listing markings or report numbers and load rating in tension and compression as evaluated by an agency acceptable to authorities having jurisdiction.
 - 4. Annotate to indicate application of each product submitted and compliance with requirements.
- B. Shop Drawings:
 - 1. Detail fabrication and assembly of equipment bases.
 - 2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
- C. Delegated Design Submittal for Each Seismic-Restraint Device.

- 1. For each seismic-restraint device, including restraint rigid and cable type, restraint accessory, and concrete anchor and insert that is required by this Section or is indicated on Drawings, submit the following:
 - a. Seismic Restraints: Select seismic restraints complying with performance requirements, design criteria, and analysis data.
 - b. Post-Installed Concrete Anchors and Inserts: Include calculations showing anticipated seismic loads. Include certification that device is approved by an NRTL for seismic reinforcement use.
 - c. Seismic Design Calculations: Submit all input data and loading calculations prepared under "Seismic Design Calculations" Paragraph in "Performance Requirements" Article.
 - d. Qualified Professional Engineer: All designated design submittals for seismic calculations are to be signed and sealed by the qualified professional engineer responsible for their preparation.
- D. Delegated Design Submittal for Each Wind-Load Protection Device:
 - 1. For each wind-load protection device, including restraint rigid and cable type, restraint accessory, and concrete anchor and insert that is required by this Section or is indicated on Drawings, submit the following:
 - a. Wind-Load Restraint: Select wind-load restraints complying with performance requirements, design criteria, and analysis data.
 - b. Post-Installed Concrete Anchors and Inserts: Include calculations showing anticipated wind loads. Include certification that device is approved by an NRTL for reinforcement use.
 - c. Wind-Load Design Calculations: Submit all static and dynamic loading calculations prepared under "Wind-Load Design Calculations" Paragraph in "Performance Requirements" Article.
 - d. Qualified Professional Engineer: All designated design submittals for wind-loadrestraint calculations are to be signed and sealed by the qualified professional engineer responsible for their preparation.
 - 2. Seismic and Wind-Load Restraint Detail Drawings:
 - a. Design Analysis: To support selection and arrangement of seismic and wind-load restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
 - c. Coordinate seismic-restraint details with wind-load details required for equipment mounted outdoors.
 - 3. Product Listing, Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).
 - 4. All delegated design submittals for seismic and wind-load restraint detail drawings are to be signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of seismic and wind-load bracing for communications components with other systems and equipment in the vicinity, including other supports and seismic restraints.
- B. Qualification Data: For professional engineer and testing agency.
- C. Field quality-control reports.
- D. Seismic Qualification Data: Provide special certification for designated seismic systems as indicated in ASCE/SEI 7-05, ASCE/SEI 7-10, ASCE/SEI 7-16, Paragraph 13.2.2, "Special Certification Requirements for Designated Seismic Systems," for all Designated Seismic Systems identified as such on the Drawings or in the Specifications.
 - 1. Provide equipment manufacturer's written certification for each designated active communications seismic device and system, stating that it will remain operable following the design earthquake. Certification must be based on requirements of ASCE/SEI7, including shake table testing per ICC-ES AC156 or a similar nationally recognized testing standard procedure acceptable to authorities having jurisdiction.
 - 2. Provide equipment manufacturer's written certification that components with hazardous contents maintain containment following the design earthquake by methods required in ASCE/SEI 7-05, ASCE/SEI 7-10, ASCE/SEI 7-16.
 - 3. Submit evidence demonstrating compliance with these requirements for approval to authorities having jurisdiction after review and acceptance by a licensed professional engineer.
- E. Wind-Load Performance Certification: Provide special certification for communications components subject to high wind exposure and impact damage and designated on Drawings or in the Specifications to require wind-load performance certification.
 - 1. Provide equipment manufacturer's written certification for each designated communications device, stating that it will remain in place and operable following the design wind event and comply with all requirements of authorities having jurisdiction.
 - 2. Certification must be based on ICC-ES or similar nationally recognized testing standard procedures acceptable to authorities having jurisdiction

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Independent agency must have experience and capability to conduct testing indicated, be and NRTL as defined by OSHA in 29 CFR 1910.7, and be acceptable to authorities having jurisdiction.
- B. Seismic and Wind-Load Restraint Device Load Ratings: Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by one or more of the following: an agency acceptable to authorities having jurisdiction.
- C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design seismic and wind-load control system.
 - 1. Seismic and Wind-Load Performance: Equipment shall withstand the effects of earthquake motions and high wind event] determined in accordance with ASCE/SEI 7-05, ASCE/SEI 7-10, ASCE/SEI 7-16.
- B. Seismic Design Calculations:
 - 1. Perform calculations to obtain force information necessary to properly select seismic-restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in ASCE/SEI 7-05]ASCE/SEI 7-10 including supplement No. 1, ASCE/SEI 7-16. ASCE/SEI 7 edition or other seismic calculation method required by authorities having jurisdiction. Where "ASCE/SEI 7" is used throughout this Section, it is to be understood that the edition referred to in this subparagraph is the edition intended as reference throughout the Section Text.
 - a. Data indicated below to be determined by Delegated Design Contractor must be obtained by Contractor and must be included in individual component submittal packages.
 - b. Coordinate seismic design calculations with wind-load calculations for equipment mounted outdoors.
 - c. Building Occupancy Category: [I] [II] [III] [IV].
 - d. Building Risk Category: [I] [II] [III] [IV].
 - e. Building Site Classification: [A] [B] [C] [D] [E] [F].
 - Calculation Factors, ASCE/SEI 7-16, Ch. 13 Seismic Design Requirements for Nonstructural Components: All section, paragraph, equation, and table numbers refer to ASCE/SEI 7-16 unless otherwise noted.
 - a. Horizontal Seismic Design Force F_p: Value is to be calculated by Delegated Design Contractor using Equation 13.3-1. Factors below must be obtained for this calculation:
 - S_{DS} = Spectral Acceleration: <Insert value>. Value applies to all components on Project.
 - 2) a_p = Component Amplification Factor: See Drawing Schedule for each component.
 - I_p = Component Importance Factor: See Structural Drawing Schedule for each component.
 - 4) W_p = Component Operating Weight: For each component. Obtain by Delegated Design Contractor from each component submittal.
 - 5) R_p = Component Response Modification Factor: See Structural Drawing Schedule for each component.
 - 6) z = Height in Structure of Point of Attachment of Component with Respect to Base: Determine from Project Drawings for each component by Delegated Design Contractor. For items at or below the base, "z" shall be taken as zero.

- h = Average Roof Height of Structure with Respect to Base: Determine from Project Drawings by Delegated Design Contractor.
- b. Vertical Seismic Design Force: Calculated by Delegated Design Contractor using method explained in ASCE/SEI 7-16, Paragraph 13.3.1.2.
- c. Seismic Relative Displacement D_{pl}: Calculated by Delegated Design Contractor using methods explained in ASCE/SEI 7-16, Paragraph 13.3.2. Factors below must be obtained for this calculation:
 - D_p = Relative Seismic Displacement that each component must be designed to accommodate: Calculated by Delegated Design Contractor in accordance with ASCE/SEI 7-16, Paragraph 13.3.2.
 - 2) I_e = Structure Importance Factor: <Insert value>. Value applies to all components on Project.
 - 3) 8_{xA} = Deflection at Building Level x of Structure A: See Structural Drawing Schedule for each component.
 - 4) 8_{yA} = Deflection at Building Level y of Structure A: See Structural Drawing Schedule for each component.
 - 5) 8_{yB} = Deflection at Building Level y of Structure B: See Structural Drawing Schedule for each component.
 - 6) h_x = Height of Level x to Which Upper Connection Point Is Attached: Determine for each component by Delegated Design Contractor from Project Drawings and manufacturer's data.
 - 7) h_y = Height of Level y to Which Upper Connection Point Is Attached: Determine for each component by Delegated Design Contractor from Project Drawings and manufacturer's data.
 - 8) A_{aA} = Allowable Story Drift for Structure A: See Structural Drawing Schedules for each component.
 - 9) A_{aB} = Allowable Story Drift for Structure B: See Structural Drawing Schedules for each component.
 - h_{sx} = Story Height Used in the Definition of Allowable Drift A_a: See Drawings Schedules for each component.
- d. Component Fundamental Period T_p: Calculated by Delegated Design Contractor using methods explained in ASCE/SEI 7-16, Paragraph 13.3.3. Factors below must be obtained for this calculation:
 - 1) W_p = Component Operating Weight: Determined by Contractor from Project Drawings and manufacturer's data.
 - 2) g = Gravitational Acceleration: 32.17 fps² (9.81 mps²).
 - K_p = Combined Stiffness of the Component, Supports, and Attachments: Determined by delegated design seismic engineer.
- Calculation Factors, ASCE/SEI 7-10, Ch. 13 Seismic Design Requirements for Nonstructural Components: All section, paragraph, equation, and table numbers refer to ASCE/SEI 7-10 unless otherwise noted.
 - a. Horizontal Seismic Design Force F_p: Calculated by Delegated Design Contractor by ASCE/SEI 7-10, Equation 13.3-1. Factors below must be obtained for this calculation:
 - 1) S_{DS} = Spectral Acceleration: See Structural Drawing Schedule for each component.
 - 2) a_p = Component Amplification Factor: See Structural Drawing Schedule for each component.

- 3) I_p = Component Importance Factor: See Structural Drawing Schedule for each component.
- 4) W_p = Component Operating Weight: For each component. Obtain by Delegated Design Contractor from equipment submittal.
- 5) R_p = Component Response Modification Factor: See Structural Drawing Schedule for each component.
- 6) z = Height in Structure of Point of Attachment of Component with Respect to Base: Determined from Project Drawings for each component by Contractor. For items at or below the base, "z" shall be taken as zero.
- 7) h = Average Roof Height of Structure with Respect to Base: Determine from Project Drawings by Delegated Design Contractor.
- b. Vertical Seismic Design Force: Calculate by Delegated Design Contractor using method explained in ASCE/SEI 7-10, Paragraph 13.3.1.
- c. Seismic Relative Displacement D_{pl}: Calculate by Delegated Design Contractor using methods explained in ASCE/SEI 7-10, Paragraph 13.3.2. Factors below must be obtained for this calculation:
 - D_p = Relative Seismic Displacement that Each Component Must Be Designed to Accommodate: Calculate by Delegated Design Contractor in accordance with ASCE/SEI 7-10, Paragraph 13.3.2.
 - 2) I_e = Structure Importance Factor: See Structural Drawing Schedule for each component. Value applies to all components on Project.
 - 3) 8_{xA} = Deflection at Building Level x of Structure A: See Structural Drawing Schedule for each component.
 - 4) 8_{yA} = Deflection at Building Level y of Structure A: See Structural Drawing Schedule for each component.
 - 5) 8_{yB} = Deflection at Building Level y of Structure B: See Structural Drawing Schedule for each component.
 - 6) h_x = Height of Level x to Which Upper Connection Point Is Attached: Determine for each component by Delegated Design Contractor from Project Drawings and manufacturer's data.
 - 7) h_y = Height of Level y to Which Upper Connection Point Is Attached: Determine for each component by Delegated Design Contractor from Project Drawings and manufacturer's data.
 - 8) A_{aA} = Allowable Story Drift for Structure A: See Structural Drawing Schedule for each component.
 - 9) A_{aB} = Allowable Story Drift for Structure B: See Structural Drawing Schedule for each component.
 - 10) h_{sx} = Story Height Used in the Definition of Allowable Drift A_a: S See Structural Drawing Schedule for each component.
- 4. Calculation Factors, ASCE/SEI 7-05, Ch. 13 Seismic Design Requirements for Nonstructural Components: All section, paragraph, equation, and table numbers refer to ASCE/SEI 7-05 unless otherwise noted.
 - a. Horizontal Seismic Design Force F_p: Calculated by Delegated Design Contractor by ASCE/SEI 7-05, Equation 13.3-1. Factors below must be obtained for this calculation:
 - 1) S_{DS} = Spectral Acceleration: See Structural Drawing Schedule for each component. Value applies to all components on Project.
 - 2) a_p = Component Amplification Factor: See Structural Drawing Schedule for each component.
 - 3) I_p = Component Importance Factor: See Structural Drawing Schedule for each component.

- 4) W_p = Component Operating Weight: Obtain by Delegated Design Contractor for each component from component submittal.
- 5) R_p = Component Response Modification Factor: See Structural Drawing Schedule for each component.
- 6) z = Height in Structure of Point of Attachment of Component with Respect to Base: Determine by Delegated Design Contractor for each component from Project Drawings. For items at or below the base, "z" shall be taken as zero.
- 7) h = Average Roof Height of Structure with Respect to Base: Determine by Delegated Design Contractor from Project Drawings.
- b. Vertical Seismic Design Force: Calculated by Delegated Design Contractor using method explained in ASCE/SEI 7-05, Paragraph 13.3.1.
- c. Seismic Relative Displacement D_p: Calculated by Delegated Design Contractor using methods explained in ASCE/SEI 7-05, Paragraph 13.3.2. Factors below must be obtained for this calculation:
 - 1) 8_{xA} = Deflection at Building Level x of Structure A: See Structural Drawing Schedule for each component.
 - 2) 8_{yA} = Deflection at Building Level y of Structure A: See Structural Drawing Schedule for each component.
 - 8_{yB} = Deflection at Building Level y of Structure B: See Structural Drawing Schedule for each component.
 - h_x = Height of Level x to Which Upper Connection Point Is Attached: Determine for each component by Delegated Design Contractor from Project Drawings and manufacturer's data.
 - 5) h_y = Height of Level y to Which Upper Connection Point Is Attached: Determine for each component by Delegated Design Contractor from Project Drawings and manufacturer's data.
 - 6) A_{aA} = Allowable Story Drift for Structure A: See Structural Drawing Schedule for each component.
 - 7) A_{aB} = Allowable Story Drift for Structure B: See Structural Drawing Schedule for each component.
 - 8) h_{sx} = Story Height Used in the Definition of Allowable Drift A_a: See Drawing Schedule for each component.
- C. Wind-Load Design Calculations:
 - 1. Perform calculations to obtain force information necessary to properly select wind-load-restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in Insert ASCE/SEI 7 edition or other wind-load calculation method required by authorities having jurisdiction. Where "ASCE/SEI 7" is used throughout this Section, it is to be understood that the edition referred to in this subparagraph is intended as referenced throughout the Section Text unless otherwise noted.
 - a. Data indicated below that are specific to individual pieces of equipment must be obtained by Contractor and must be included in individual component submittal packages.
 - b. Coordinate design wind-load calculations with seismic load calculations for equipment requiring both seismic and wind-load reinforcement. Comply with requirements in other Sections in addition to those in this Section.
 - 2. Design wind pressure "p" for external sidewall-mounted equipment is to be calculated by Delegated Design Contractor using methods in ASCE/SEI 7-16, Ch. 30. Perform calculations according to one of the following, as appropriate:

- a. PART 1: Low-Rise Buildings.
- b. PART 2: Low-Rise Buildings (Simplified).
- c. PART 3: Buildings with "h" less than 60 ft. (18.3 m).
- d. PART 4: Buildings with "h" greater than 60 ft. (18.3 m) and less than 160 ft. (48.8 m).
- e. PART 5: Open Buildings.
- 3. Design wind pressure "p" for rooftop equipment is to be calculated by Delegated Design Contractor using methods in ASCE/SEI 7-16, Ch. 30, PART 6: Building Appurtenances and Rooftop Structures and Equipment.
 - a. Risk Category: See structural requirements.
 - b. h = Mean Roof Height: Refer to architectural and structural drawings.
 - c. V = Basic Wind Speed: See Structural requirements.
 - d. K_d = Wind Directionality Factor: See Structural requirements.
 - e. Exposure Category: ASCE/SEI 7-16 Section 26.7 or other source approved by authorities having jurisdiction.
 - f. K_{zt} = Topographic Factor: ASCE/SEI 7-16 Section 26.7 or other source approved by authorities having jurisdiction.
 - g. K_e = Ground Elevation Factor: ASCE/SEI 7-16 Section 26.7 or other source approved by authorities having jurisdiction.
 - h. K_z = Velocity Pressure Exposure Coefficient (Evaluated at Height z): ASCE/SEI 7-16 Section 26.7 or other source approved by authorities having jurisdiction.
 - i. K_h = Velocity Pressure Exposure Coefficient (Evaluated at Height h): ASCE/SEI 7-16 Section 26.7 or other source approved by authorities having jurisdiction.
 - j. q_z = Velocity Pressure: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-16 Section 26.10.1 or other source approved by authorities having jurisdiction.
 - k. q_h = Velocity Pressure: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-16 Section 26.10.1 or other source approved by authorities having jurisdiction.
 - 1) G = Gust-Effect Factor: ASCE/SEI 7-16 Section 26.7 or other source approved by authorities having jurisdiction.
 - 2) Enclosure Classification: ASCE/SEI 7-16 Section 26.7 or other source approved by authorities having jurisdiction.
 - GC_{pi} = Internal Pressure Coefficient: ASCE/SEI 7-16 Section 26.7 or other source approved by authorities having jurisdiction.

2.2 **RESTRAINTS - RIGID TYPE**

A. Description: Shop- or field-fabricated bracing assembly made of ANSI/AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.3 **RESTRAINTS - CABLE TYPE**

A. Seismic and Wind-Load Restraint Cables: ASTM A492 stainless steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for seismic restraining cable service; with fittings attached by means of poured socket, swaged socket or mechanical (Flemish eye) loop. B. Restraint cable assembly and cable fittings must comply with ASCE/SEI 19. All cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

2.4 **RESTRAINT ACCESSORIES**

- A. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or Reinforcing steel angle clamped to hanger rod. Non-metallic stiffeners are unacceptable.
- B. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.
- C. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- D. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
- E. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.5 POST-INSTALLED CONCRETE ANCHORS

- A. Mechanical Anchor Bolts:
 - 1. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength for anchor and as tested according to ASTM E488/E488M.
- B. Adhesive Anchor Bolts:
 - 1. Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.
- C. Provide post-installed concrete anchors which have been prequalified for use in seismic applications. Post-installed concrete anchors must comply with all requirements of ASCE/SEI 7
 - 1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
 - 2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.

2.6 CONCRETE INSERTS

- A. Provide preset concrete inserts which are seismically prequalified in accordance with ICC-ES AC466 testing.
- B. Comply with MSS SP-58.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive seismic and wind-load control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- B. Hanger-Rod Stiffeners: Install where required to prevent buckling of hanger rods caused by seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry static, wind load, and seismic loads within specified loading limits.

3.3 INSTALLATION OF SEISMIC RESTRAINT AND WIND-LOAD CONTROL DEVICES

- A. Provide seismic-restraint and wind-load control where required by applicable codes.
- B. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."
- C. Installation of seismic and wind-load restraints must not cause any stresses, misalignment, or change of position of equipment or conduits.
- D. Equipment Restraints:
 - 1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
 - 2. Install seismic-restraint and wind-load restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- E. Raceway, Cable, Wireway, Cable Tray, and Busway Support and Hanger Restraints:
 - 1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
 - 2. Install seismic-restraint and wind-load restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.

- 3. Comply with requirements in NFPA 70 and ASCE/SEI 7.
- F. Install cables so they do not bend across edges of adjacent equipment or building structure.
- G. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- H. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- I. Post-Installed Concrete Anchors:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 3. Mechanical-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - 4. Adhesive-Type Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 - 5. Set anchors to manufacturer's recommended torque using a torque wrench.
 - 6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where connection is terminated to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Contractor shall engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
 - 1. Perform tests and inspections
 - 2. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 - 3. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
 - 4. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.

- 5. Test no fewer than 10% of each type and size of installed anchors and fasteners selected by Architect.
- 6. Test to 90 percent of rated proof load of device.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Seismic controls will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

END OF SECTION 270548

SECTION 27 1000 STRUCTURED CABLING SYSTEM

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. General: Telecommunications Drawings apply to work of this section. The overall and detailed Structured Cabling System (SCS) design shown on the drawings, selected materials, device locations, installation details, mounting details, cabling routing and supporting and all technical specifications if provided on the drawings apply to work of this section.
- B. General: Furnish, install, test and certify complete with all accessories an ANSI/TIA 568D SCS with a minimum 25 year performance warranty for the entire system from the manufacturers and a minimum of 3 years warranty for materials and labor from the SCS installer for all components not covered under the manufacturer's 25 year warranty. The goal of the project is to provide an enhanced SCS that shall serve as a vehicle for the transport of voice telephony, data, audio, video, security and low voltage devices for building controls and management, throughout the building and from building to building from designated demarcation points to outlets located at various desk, workstation and other locations as indicated in the contract drawings.
- C. Coordination with other trades: It is the responsibility of the installer of the SCS to verify and advise the installer of the raceway infrastructure (conduit, boxes, cable tray, in ground boxes, etc.) for this system on raceway routing to minimize the wiring distances to the telecommunication room. When J-hooks are acceptable for the use in structured cabling system, all J-hooks and supports for these devices shall be in the scope of work of the SCS installer.
- D. All patching and cross connect to owner provided equipment shall be included under the scope of work of this project.
- E. During the execution of the work, all required relocation, demolition, temporary connections, rerouting, etc., of existing cabling, equipment and systems in the existing building areas where the work is required, shall be performed by the SCS installer, as indicated on the drawings, or as required by job conditions and as determined by the Architect in the field, to facilitate the installation of the new systems. The Owner shall require continuous operation of the existing systems, while demolition, relocation work or new tie-ins are performed.
- F. WAP installation. The scope of work includes the installation of the Wireless Access Points (WAPs) provided by the owner. The scope includes the labor and installation materials (supports, anchors, etc.) to properly fasten the WAPs to the structure.

1.2 RELATED DOCUMENTS

- A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section
- B. Supplemental: Refer to the specification sections identified below for additional requirements, which are supplemented by this section:

SECTION	Тітье
270010	TECHNOLOGY GENERAL PROVISIONS
270528	RACEWAYS FOR TECHNOLOGY
270526	GROUNDING & BONDING FOR TELECOMMUNICATIONS SYSTEMS

- C. Owner standards: Comply with the document "Requirements for all Communication Cabling at Clients name" prepared by the Clients applicable office.
- D. Standards: All work related to the SCS shall be in compliance with the following industry codes and standards latest edition:
 - 1. ANSI/TIA-568.0-D "Generic Telecommunications Cabling for Customer Premises" with addendums and errata.
 - 2. ANSI/TIA-568.1-D, "Commercial Building Telecommunications Cabling Standard" with addendums and errata.
 - 3. ANSI/TIA-568.2 D, "Balanced Twisted- Pair Cabling Components Standard" with addendums and errata.
 - 4. ANSI/TIA-568.3-D, "Optical Fiber Cabling Component Standard" with addendums and errata.
 - 5. ANSI/TIA-569-D, "Telecommunications Pathways and Spaces" with addendums and errata.
 - 6. ANSI/TIA-606-C, "Administration Standard for Telecommunications Infrastructure" with addendum and errata.
 - 7. ANSI/TIA-607-D, "Generic Telecommunications Bonding and Grounding (earthing) for Customer Premises" with addendum and errata.
 - 8. ANSI/NECA/BICSI 607-2011, Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings.
 - 9. ANSI/TIA 758-B, " Customer-Owned Outside Plant Telecommunications Infrastructure Standard" with addendum and errata
 - 10. ANSI/TIA 862-B, "Structured Cabling Infrastructure Standard for Intelligent Building Systems" with addendum and errata.
 - 11. ANSI/TIA-1152-A, "Requirements for Field Test Instruments and Measurement for Balanced Twisted Pair Cabling" with addendum and errata.
 - 12. ANSI/TIA-526-7-A, "Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant".
 - 13. ANSI/TIA-526-14-C, "Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant".
 - 14. TIA-598-D, Optical Fiber Cable color coding.
 - 15. IEC/TR3 61000-5-2 Ed. 1.0 and amendments. "Electromagnetic compatibility (EMC) -Part 5: Installation and mitigation guidelines - Section 2: Earthing and cabling"
 - 16. ANSI/TIA-942-B, "Telecommunications Infrastructure Standard for Data Centers" with addendum and errata
 - 17. ANSI/BICSI 002-2014, Data Center Design and Implementation Best Practices
 - 18. ANSI/NFPA 70 "National Electrical Code", CSA C22.1.
 - 19. BICSI Telecommunications Distribution Methods Manual (TDMM)
 - 20. BICSI Telecommunications Cabling Installation Manual (TCIM)
 - 21. BICSI Customer Owned Outside Plant Manual (COOPM)
 - 22. Local County/City Codes, Ordinances and Regulations.
 - 23. Underwriters Laboratories (UL)
 - 24. FCC -Federal Communications Commission
 - 25. ADA Requirements
 - 26. Occupational Safety and Health Regulations (OSHA)
 - 27. National Fire Protection Association (NFPA)
 - 28. ANSI/TIA-1179, Healthcare Facility Telecommunications Infrastructure Standards
 - 29. Manufacturers Product Cabling Catalogs
 - 30. Manufacturers Training Manuals (Design and Installation).

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

Project No. 121505 Structured Cabling System Section 27 1000 - 2

TLC Engineering Solutions

E. General: Installation practices for SCS as describe herein take precedence over any other section in the construction documents set.

1.3 STRUCTURED CABLING SYSTEM INSTALLER QUALIFICATIONS

- A. General: The installer selected for the project must be certified by the manufacturers of the products, adhere to the engineering, installation and testing procedures and utilize the authorized manufacturers components and distribution channels in provisioning the Project.
- B. General: The installer directly responsible for this work shall be a Structured Cabling System (SCS) Installer who is, and who has been, regularly engaged in the providing and installation of commercial and industrial telecommunications wiring systems of this type and size for at least the immediate past five years. Any other company working for the SCS installer of this system shall have the same training and certification as the SCS installer.
- C. Certification: The SCS installer's Project Manager shall possess a current and in Good Standings BICSI Registered Communications Distribution Designer (RCDD®) certificate. All shop drawings submitted by the SCS Installer shall bear the RCDD's stamp.
- D. The SCS Installer shall have a (BICSI) RCDD on Staff. Third party RCDD's shall not be acceptable.
- E. The Installer team leader assigned for the project shall be BICSI registered Level II installer or proven and qualified equal.
- F. Experience: The SCS Installer shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size. The SCS Installer shall own and maintain tools and equipment necessary for successful installation and testing of SCS and have personnel who are adequately trained in the use of such tools and equipment. The Owner or engineer may elect to request submittal of additional financial, operational and administrative information of the SCS installer to demonstrate the required experience.

1.4 MATERIALS ALTERNATES AND SUBSTITUTIONS

- A. SCS Installer shall follow all requirements for materials alternates and substitutions indicated in specification section 270010.
- B. Substitutions are only allowed for the SCS when the substitutions do not change the warranty of the SCS system as indicated in this specification section

1.5 SHOP DRAWINGS AND SUBMITTALS.

- A. See additional requirements for shop drawings and submittals in specification section 270010.
- B. Proposal Submittals: The SCS Installer shall submit the following information with the proposal to execute the work:
 - 1. A list of five (5) recently completed projects of similar type and size with contact names and telephone numbers for each.
 - 2. A list of test equipment proposed for use in verifying the integrity of the installed SCS. Test equipment list shall include manufacturer part number, serial numbers and a copy of

the last calibration report done by the manufacturer of the equipment of the unit, indicating the date when the calibration was done. Calibrations shall not be older than one year. Test equipment includes, cable certifiers, OTDRs, fiber splicers, etc.

- 3. A technical resume of experience for the installer's engineer/RCDD and on-site foreman who will be assigned to the project, including RCDD license number.
- 4. Similar documentation for any company working for the SCS Installers who will assist in the performance of this work.
- 5. A copy of a current and valid Low voltage License for the State of Florida.
- 6. Location of office from which installation and warranty work will be performed.
- C. Construction submittals: Once all proposal submittals have been received and approved by the Architect and Engineer (A&E) of the project, the SCS Installer shall provide all construction submittals. Construction submittals are composed of the following items.
 - 1. Manufacturer's cut sheets for all proposed equipment as described in Part 2 of this specification section. Cut sheets shall bear the printed logo or trademark of the manufacturer for each type of product being provided. Mark each copy of the cut sheets for the specific product being provided with an identifying mark, arrow, or highlighting.
 - 2. Faceplate color selection.
 - 3. Detail explanation of the labeling scheme to be used for all components of the system. This explanation shall include examples of all types of labels to be used, like labels for cables, patch panels, outlet jacks, etc.
 - 4. Autocad® or Revit drawings in sheets matching the size of the design documents with the following information:
 - a. Floor plans with all outlets in the project. All outlets shall have the label to be used during identification and tagging process described in this specification section.
 - b. Enlarged telecommunication rooms with all equipment components and rack layouts for each room. All racks shall have the label to be used during identification and tagging process described in this specification section.
 - c. Drawings indicating rack elevations for all cabinets or racks in the project, identifying the precise quantity of patch panels, fiber distribution centers and wire managers and accurate RU heights based on equipment selection. All equipment shall have the label to be used during the identification and tagging process described in this specification section.
 - d. A spreadsheet indicating all patch cords (fiber and copper) to be provided in the project. The spreadsheet shall indicate the quantity, color of the jacket, cable type, length and connector termination on each side.
- D. Construction submittals received before proposal submittals are received or approved will be rejected.

1.6 ABBREVIATIONS

- A. General: The following abbreviations are used in this specification section:
 - 1. A&E Architect and Engineer. The Architect is the legal entity that holds a contract for the design the project. The Engineer is the consulting engineer firm or engineer of record for the project who prepared this specification.
 - 2. APC Angle physical contact connector. Reference to the polish style of the ferrule in fiber optic connectors.
 - 3. Array connector a multi-strand fiber connector user for high density applications, such as the MPO connector
 - 4. BICSI Building Industry Consultant Services International
 - 5. CCTV Close circuit television system (surveillance video system)
 - 6. FCC Federal Communications Commission.
 - 7. FTP Foiled Twisted pair. One foiled screen around each cable pair.

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 121505 Structured Cabling System Section 27 1000 - 4

- 8. IDC Insulation Displacement Connector
- 9. NEC National Electrical Code.®
- 10. NEMA National Electrical Manufacturers Association.
- 11. OM1 ISO 11801 designation for multimode 62.5/125µm glass fiber optics.
- 12. OM2 ISO 11801 designation for multimode 50/125µm glass fiber optics.
- 13. OM3 ISO 11801 designation for multimode laser optimized 50/125µm glass fiber optics.
- 14. OM4 TIA designation for multimode laser optimized 50/125µm glass fiber optics in compliance with TIA-492-AAAD.
- 15. OS1 ISO 11801 designation for single mode 9/125µm glass fiber optics.
- 16. OS2 ISO 11801 designation for single mode 9/125µm glass fiber optic with performance criteria identical to ITU-T G652.
- 17. OTDR Optical Time Domain Reflectometer.
- 18. RU Rack units. Height dimension for rack mounted equipment. 1 RU equivalent to 1.75".
- 19. SCS Structured Cabling System
- 20. ScTP Screened twisted pair. One foiled screen around all cable pairs
- 21. TIA Telecommunications Industry Association.
- 22. TR Telecommunications Room.
- 23. UPC Ultra physical contact connector. Reference to the polish style of the ferrule in fiber optic connectors.
- 24. UTP Unshielded twisted Pair
- 25. UV Ultra violet
- 26. VAC Volts alternating current.

PART 2 - PRODUCTS

2.1 MODULAR SCS JACKS

- A. Structured cabling system outlets indicated in design drawings are composed of modular SCS jacks, mounted in a faceplate on an electrical box. Modular SCS jacks shall be 8-pin modules (RJ-45) that meet or exceed the following electrical and mechanical specifications:
 - 1. Électrical Specifications:
 - a. Insulation resistance: 500 M Ω minimum.
 - b. Dielectric withstand voltage 1,000 VAC RMS, 60 Hz minimum, contact-to-contact and 1,500 VAC RMS, 60 Hz minimum from any contact to exposed conductive surface.
 - c. Contact resistance: 20 M Ω maximum.
 - d. Current rating: 1.5 A at 68 ° F (20 ° C) per IEC publication 512-3, Test 5b
 - e. ISO 9001 Certified Manufacturer
 - f. UL verified for ANSI/TIA electrical performance
 - g. Comply with FCC Part 68
 - h. Cable termination: IDC type universal T568A or T568B.
 - 2. Mechanical Performance:
 - a. Plug Insertion Life: 750 insertions
 - b. Contact Force: 3.5 oz (99.2 g) minimum using FCC-Approved modular plug.
 - c. Plug Retention Force: 30 lb (133 N) minimum between modular plug and jack.
 - d. Temperature Range: -40° to 150°F (-40 ° to 66 ° C)
- B. Design selection: modular SCS jacks shall be selected according to the following criteria:
 - 1. Performance requirement: CAT6A
 - 2. Style: Rear loading
 - 3. Mounting orientation: straight mounting
 - 4. Color: Match cable color based on application

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

Project No. 121505 Structured Cabling System Section 27 1000 - 5

TLC Engineering Solutions

- 5. Dust cover required: No
- 6. Shielding: use shielded modular jacks only with ScTP cable.
- C. Approved manufacturer: Ortronics, Panduit, Siemon, CommScope, Belden, Leviton or Hubbell.

2.2 FIELD TERMINATABLE 8 POSITION MODULAR PLUG

- A. When indicated in the design drawings to use Direct Attach connection for any field devices, field terminatable 8 positions modular plugs shall be used. This devices shall be 8-pin modules (RJ-45) plugs that meet or exceed the following electrical and mechanical specifications:
 - 1. General Specifications:
 - a. Shall include an IDC type of termination for the cable. Crimp type terminations not acceptable.
 - b. Shall support cable gauges from 22 to 26 AWG
 - c. Shall include a rubber boot
 - 2. Electrical Specifications:
 - a. ISO 9001 Certified Manufacturer
 - b. UL verified for ANSI/TIA electrical performance
 - c. Comply with FCC Part 68
 - d. Cable termination: IDC type universal T568B.
- B. Design selection: modular SCS jacks shall be selected according to the following criteria:
 1. Performance requirement: Match performance of Modular SCS jacks
- C. Approved manufacturer: Match selection for modular SCS jacks.

2.3 OTHER MODULAR JACKS

- A. Whenever indicated in the design drawings SCS outlets could have terminations for other media types like fiber optic cables, coaxial cables or audio cables. Whenever those type of media are indentified in the drawings, the following specifications shall be meet for modular jacks mounted in SCS outlets:
 - 1. Style, mounting orientation and color: match design selection for modular SCS jacks.
 - 2. Broadband distribution system connector: Use modular jack with F connector bulkhead rated at 75Ω .
 - 3. Fiber optic connectors: use modular jack with adapter plate for LC duplex connector.
 - 4. For line level audio signals: use modular jack with RCA connector bulkhead. Use different color coded insulators for different audio channels.
- B. Approved manufacturer: Match selection for modular SCS jacks.

2.4 FACEPLATES

- A. Faceplates shall be used for all flush mounted telecommunication outlets to house modular jacks. Faceplates shall have the following specifications:
 - 1. Construction material: High impact thermo Plastic.
 - 2. Size: use single gang faceplates only unless specifically noted in the design drawings.
 - 3. Capacity of modular jacks per faceplate: faceplate shall be selected as to accommodate the amount of cables in each telecommunication outlet. No more than one unused opening shall be present on each faceplate.
 - 4. Color: submit color to A&E for approval.

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 121505 Structured Cabling System Section 27 1000 - 6

- 5. Labels: faceplate shall have two (2) recesses for labels, top and bottom, and shall have transparent label snap-on covers.
- 6. Faceplate style: Direct modular plug rear loading style
- B. All faceplates shall have a tamper resistant cover to access the modular jacks
- C. Approved manufacturer: Match selection for modular SCS jacks.

2.5 FACEPLATES WITH SUPPORT STUDS

- A. Telecommunication outlets indicated in the design drawings as to be wall mounted telephone outlets shall be composed of one modular SCS jack and one faceplate with support studs mounted on an electric box. Faceplates with support studs shall have the following specifications:
 - 1. Construction material: Stainless Steel.
 - 2. Size: use single gang faceplate with two support studs.
 - 3. Capacity of modular jacks per faceplate: One.
 - 4. Faceplate style: Direct modular plug rear loading style.
- B. Approved manufacturer: Match selection for modular SCS jacks.

2.6 SURFACE MOUNTED BOXES

- A. Telecommunication outlets indicated in the design drawings as to be surface mounted outlets shall be composed of modular jacks mounted in a surface mounted box inside an electrical enclosure. Surface mounted boxes shall have the following specifications:
 - 1. Construction material: High impact thermo Plastic.
 - 2. Capacity of modular jacks per surface mounted box: size of surface mounted box shall be selected as to accommodate the amount of cables in the surface mounted telecommunication outlet. No more than one unused opening shall be present on each box.
 - 3. Color: White.
 - 4. Labels: surface mounted boxes shall have at least one (1) recess for labels, and shall have transparent label snap-on covers
- B. Approved manufacturer: Match selection for modular SCS jacks.

2.7 MOUNTING FRAMES

- A. All telecommunication outlets shall be properly mounted in the electrical raceway system provided for the outlet. The SCS installer shall select the proper mounting frame and/or bezel to mount the modular plugs in the raceway system. Raceway systems include furniture systems, floor boxes, poke-thrus, power poles, surface raceways system, etc.
- B. Whenever design drawings indicate a telecommunication outlet to be mounted in a furniture system the SCS Installer shall select the proper mounting frame to hold the modular jacks in the furniture system selected by the owner. Color of the mounting frames shall match the color of the furniture system.
- C. If owner provided furniture system does not have a raceway system for telecommunication, and design drawings indicate outlet to be mounted in the furniture system, SCS installer shall

provide a plastic surface mounted box that allows the mounting of the modular plugs in a standard telecommunication faceplate.

- D. SCS installer shall provide all mounting frames and bezels to mount modular jacks inside floor boxes or poke-thrus.
- E. All un-used ports in mounting frames shall be covered with blank inserts.
- F. Approved manufacturer: Match selection for modular SCS jacks.

2.8 HORIZONTAL 4-PAIR CABLE

- A. General: Horizontal 4-pair cables shall be extended between the telecommunications outlet location and its associated equipment inside the TR. The cable shall consist of 4 pair cable solid copper conductors, certified to the specified performance standard. All horizontal 4-pair cables shall be terminated in modular jacks and patch panels with IDC type connectors and shall have the following specifications:
 - 1. Cable Gauge: minimum 23 AWG
 - 2. Performance standard: ANSI/TIA CAT6A
 - 3. Cable type: UTP
 - 4. Performance characterized to: 600 MHz
 - 5. Time delay skew: Maximum 45 ns/100m
 - 6. Input impedance (1-100MHz): 100Ω
 - 7. Cable diameter: ≤ 0.295 inch
- B. Cable jacket colors for 4-pair horizontal cables shall be selected according to the following criteria:
 - 1. Voice or data cables: Blue
 - 2. Wireless access points: Green
 - 3. Surveillance cameras: Purple
- C. Performance verification: All performance of horizontal 4-pair cable shall be verified by a Nationally Recognized Testing Laboratory (NRTL) for ANSI/TIA electrical performance and comply with FCC Part 68.
- D. Jacket: Cable jacket for inside premise cables shall comply with Article 800 NEC for correct use in the environment in which they will be used. If at the moment of the bid the SCS installer does not know the environment, in which cables will be used, the SCS installer shall assume plenum rated is required for the project. At a minimum all cables shall have a flame retardant PVC jacket riser rated.
- E. OSP Jackets: All horizontal 4-pair cables run in conduits below the floor slab shall have a water resistant flooding compound and a jacket made of UV resistant polyethylene. Cables with PVC jackets are not acceptable for this application.
- F. Jacket marking: All horizontal 4-pair cables shall have at least two types of markings imprinted in the jacket, transmission performance marking and NEC rating for environment to be used.
- G. Approved manufacturer: Corning, Superior Essex, Belden, Panduit, Siemon, CommScope General Cable, or Berk-Tek.

2.9 PATCH PANELS FOR HORIZONTAL CABLING

- A. All 4-pair horizontal cables shall be terminated in rack mounted path panel located in the telecommunication rooms rack. These patch panels shall have the following specifications.
 - 1. Connector type: 8-position modular plug (RJ-45)
 - 2. Cable termination: IDC type universal T568A or T568B.
 - 3. Performance requirement: CAT6A
 - 4. Maximum connectors per path panel allowed: 48
 - 5. Patch panel type: factory rear loaded panels (use modular SCS jacks for all inserts)
 - 6. Patch panel shape: straight (flat)
 - 7. Permanent marking: All connectors shall be labeled in sequential numbers
 - 8. Field labels: patch panels shall have a space for field labels covered with transparent protectors.
 - 9. Shielding: use shielded patch panels only with ScTP cable.
- B. Approved manufacturers. Match selection for modular SCS jacks

2.10 HORIZONTAL WIRE MANAGERS

- A. Horizontal wire managers shall be mounted in racks to route cables from patch panels to vertical wire managers and to equipment. Horizontal wire managers shall have the following specification:
 - 1. Style: Finger duct style with hinged cover multiple rings finger duct style with removable cover
 - 2. Sides: front of rack
 - 3. Minimum height: two RU
- B. Approved manufacturers. Match selection for modular SCS jacks

2.11 CROSS OVER WIRE MANAGERS

- A. Cross over wire managers shall be used to route patch cables from the right vertical wire manager to the left vertical wire manager or between racks. Cross over wire managers shall have the following specification:
 - 1. Style: six port finger spacing with a cover
 - 2. Sides: front of rack
 - 3. Minimum height: Four RU
- B. Approved manufacturers. Match selection for modular SCS jacks

2.12 FOUR (4) PAIR PATCH CORDS

- A. Four (4) pair patch cords are required at the work area side and at the patch panel side to complete the connectivity path to the equipment. All 4-pair patch cords shall be factory tested and shall have molded boots to the cable jacket. Field made patch cords are not acceptable. Four pair patch cords shall have the following specifications:
 - 1. Connectors: 8-pin modular plugs at both ends
 - 2. Conductors: 4-pair stranded conductors.
 - 3. Wire gauge: 23AWG for patch cords in the field site and 28 AWG for patch cords in the telecom room side
 - 4. Wiring map: See section 3 of this specification

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 121505 Structured Cabling System Section 27 1000 - 9

TLC Engineering Solutions

- 5. Performance requirement: To match horizontal 4-pair cable performance
- 6. Cable type: UTP
- B. Approved manufacturers. Match selection for modular SCS jacks

2.13 SINGLE STRAND FIBER OPTICS CONNECTORS

- A. All fiber optic cables (horizontal or backbone cables) shall be terminated on fiber optic connectors at both ends of the cable with either single strand fiber optic connectors or array connectors. Single strand fiber optic connector shall be compliant with industry standard ANSI/TIA-568-C.3 and the applicable ANSI/TIA Fiber Optic Connector Intermateability Standard (FOCIS) document, ANSI/TIA 604 series. Single strand fiber optic connectors shall have the following specification:
 - 1. Physical contact type: use UPC type connector for all application with the exception of applications of Broadband TV distribution systems or DAS systems. For those applications use APC type connectors.
 - 2. Connector type: LC
 - 3. Security level: non-keyed connector
 - 4. Pairing style: duplex
 - 5. Acceptable connector attachment types:
 - a. Epoxy type connectors, field polished
 - b. Epoxyless (Crimp) type connector, field polished.
 - c. Fusion spliced pig tail with factory polished connector. Mechanical splices for pig tails are not acceptable.
 - 6. Fiber type: SCS installer shall select the connector according to the fiber type where connector will be installed. As an example use OM1 connectors only in OM1 fiber optic cables.
 - 7. Fusion spliced pig tails. When using fusion spliced pig tails the SCS installer shall make sure the fiber type of the pig tail and the actual cable have the same optical characteristics, such as back scatter, core diameter, etc.
 - 8. Ferrule construction: use ceramic ferrule connectors only, plastic ferrules are not acceptable.
- B. All single strand fiber optic connectors shall include boots to protect the fiber optic cable. The SCS installer shall select the boot according to the fiber optic type selected. As an example use 900µm boots in 900µm coated fiber, use 250µm boots on 250µm coated fiber and use 2mm boots on 2mm jacketed fiber. All boots shall be color coded to identify the type of fiber connector used. Boots shall be beige for OM1 fiber, black for OM2, aqua for OM3 and OM4 or green.
- C. Single strand multimode fiber optic connectors shall have the following performance requirements:
 - 1. The maximum insertion loss shall be 0.75 dB (maximum) when installed in accordance with the manufacturer's recommended procedure and tested in accordance with FOTP-171.
 - 2. Connector reflectance shall be less than or equal to -26 dB when installed in accordance with the manufacturer's recommended procedure.
 - 3. Connectors shall sustain a minimum of 500 mating cycles without violating specifications.
 - 4. Connectors shall have an optical axial pull strength of 2.2 N (0.5lbf) at 90° angle, with a maximum 0.5dB increase in attenuation for both tests when tested in accordance with ANSI/TIA-455-6B.
- D. Single strand single mode fiber optic connectors shall have the following performance requirements:
- 1. Maximum insertion loss shall be 0.75 dB per each mated connector pair when installed in accordance with the manufacturer's recommended procedure and tested in accordance with FOTP-171.
- 2. Connector reflectance shall be less than or equal to -40 dB (UPC) when installed in accordance with the manufacturer's recommended procedure.
- 3. Connectors shall sustain a minimum of 500 mating cycles without violating specifications.
- 4. Connectors shall have an optical axial pull strength of 2.2 N (0.5lbf) at 90° angle, with a maximum 0.5 dB increase in attenuation for both tests when tested in accordance with ANSI/TIA-455-6B.
- 5. Connectors shall meet the following performance criteria: Test Procedure Maximum Attenuation Change (dB) Cable Retention FOTP-6 0.2 dB Durability FOTP-21 0.2 dB Impact FOTP-2 0.2 dB Thermal Shock FOTP-3 0.2 dB Humidity FOTP-5 0.2 dB
- E. Approved manufacturers. Corning, Belden, Panduit, Siemon, CommScope

2.14 FIBER OPTICS SPLICES

- A. When fiber splicing is required in the project because of the use of pigtails or field splicing, only fusion splicing will be acceptable. Mechanical splices shall not be used unless specifically indicated in the contract documents.
- B. All fiber splices shall be terminated with heat shrink sleeves and organized in splice trays. Splice trays sizes shall be selected to match the quantity of fiber strands in the cable bundles. Splice trays shall be organized in Fiber Optics Distribution Centers when inside a telecom room or in outdoor rated splice closures when done outdoors.
- C. Fusion splice equipment to be used in this project shall have the following specifications:
 - 1. Alignment system: Automatic Core Detection system (ACD). V-groove splicers are not allowed.
 - 2. Typical splice loss for single mode fibers: 0.02 dB
 - 3. Splice loss result: Estimated (ACD) Measurement (LID)
 - 4. Unit shall have a fast heat shrink oven, maintenance free electrodes, built in cleaver and graphical user interface to display alignment condition.
 - 5. Cleaver blade type: diamond.

2.15 INSIDE PREMISE FIBER OPTICS HORIZONTAL CABLES

- A. Telecommunications outlets could have fiber optic terminations. Whenever design drawings indicate fiber optic terminations, inside premise fiber optic horizontal cables shall be used. The following are the specifications for fiber optic horizontal cables:
 - 1. Strand Count: Two (2) strands
 - 2. Fiber type: OM4 OS1/OS2 as indicated in design drawings
 - 3. Fiber coating: 900µm coating color coded
 - 4. Fiber protection: aramid yarn
 - 5. Jacket type: 2.9mm flame-retardant PVC jacket zip-cord type.
 - 6. Color jacket: jacket shall be aqua for OM3 or OM4 fiber and yellow for OS1 or OS2 fiber.
- B. Jacket: Cable jackets for fiber optic cables shall comply with Article 770 NEC for correct use in the environment in which they will be used. If at the moment of the bid the SCS installer does

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 121505 Structured Cabling System Section 27 1000 - 11 not know the environment, in which cables will be used, the SCS installer shall assume plenum rated is required for the project. At a minimum all cables shall have a flame retardant PVC jacket riser rated. Rating shall be printed in the cable jacket.

- C. OSP Jackets: All fiber optic horizontal cables run in conduits below the floor slab shall have a water resistant flooding compound and a jacket made of UV resistant polyethylene. Cables with PVC jackets are not acceptable with this application.
- D. Approved manufacturers. Corning, Belden, Panduit, Siemon, CommScope

2.16 INSIDE PREMISE FIBER OPTICS BACKBONE CABLES

- A. Whenever design drawings indicate fiber optics backbone cables to be run inside premises, the following specification shall be followed for those cables:
 - 1. Strand Count: As indicated in design drawings
 - 2. Fiber type: As indicated in design drawings
 - 3. Fiber coating: 900µm coating color coded. 250µm coating is acceptable for loose buffer cables but they shall be protected with break-out kits with color coded 900µm buffers at both ends of the cable.
 - 4. Fiber protection: aramid yarn around all strands for cables under 24 strands, and aramid yarn and jacket around each subunit (6 or 12 strands) for cables above 24 strands.
 - 5. Interlock requirement: Interlock aluminum [dielectric] armor is required
 - 6. Jacket type: Flame-retardant PVC jacket or materials with superior performance.
 - 7. Color jacket: jacket shall be aqua for OM3 or OM4 fiber and yellow for OS1 or OS2 fiber.
 - 8. Fiber termination: fibers shall be field terminated
 - 9. Buffer type: tight buffer required loose buffer acceptable.
 - 10. Center strength member material: dielectric material
- B. Jacket: Cable jackets for fiber optic cables shall comply with Article 770 NEC for correct use in the environment in which they will be used. If at the moment of the bid the SCS installer does not know the environment, in which cables will be used, the SCS installer shall assume plenum rated is required for the project. At a minimum all cables shall have a flame retardant riser rated jacket. Rating shall be printed in the cable jacket.
- C. Approved manufacturers: Corning, Belden, Panduit, Siemon, CommScope

2.17 OUTSIDE PLANT FIBER OPTICS BACKBONE CABLES

- A. Whenever design drawings indicate fiber optics backbone cables to be run between building or outside premises, the following specification shall be followed for those cables:
 - 1. Strand Count: As indicated in design drawings
 - 2. Fiber type: As indicated in design drawings
 - 3. Fiber coating: 250µm coating protected with break-out kits with color coded 900µm buffers at both ends of the cable when cables are terminated in conditioned spaces. When fibers are terminated in outdoor non-conditioned spaces break out kits shall be used with 3 mm tubes with aramid yarn for each fiber. Unprotected 900µm fibers in non-conditioned spaces are not allowed.
 - 4. Rodent protection requirement: required
 - 5. Buffer type: Loose tube.
 - 6. Center strength member material: dielectric material

- B. Jacket: All outside plant fiber optics backbone cables shall have UV resistant cable sheathing and a water blocking material to prevent water intrusion. All outside plant fiber optics backbone cables shall be tested and in compliance with following standards:
 - 1. ANSI/TIA-568-C
 - 2. Telcordia GR-20
 - 3. ANSI/ICEA S-87-640
- C. Approved manufacturers. Corning, Belden, Panduit, Siemon, CommScope

2.18 INDOOR/OUTDOOR FIBER OPTICS BACKBONE CABLES

- A. Whenever design drawings indicate indoor/outdoor fiber optics backbone cables to be run between buildings or outside premises, the following specification shall be followed for those cables:
 - 1. Strand Count: As indicated in design drawings
 - 2. Fiber type: As indicated in design drawings
 - 3. Fiber coating: 900µm coating color coded. 250µm coating is acceptable for loose buffer cables but they shall be protected with break-out kits with color coded 900µm buffers at both ends of the cable. When fibers are terminated in outdoor non-conditioned spaces break out kits shall be used with 3 mm tubes with aramid yarn for each fiber. Unprotected 900µm fibers in non-conditioned spaces are not allowed.
 - 4. Rodent protection requirement: required
 - 5. Buffer type: tight buffer required loose buffer acceptable.
 - 6. Center strength member material: dielectric material
- B. Jacket: All indoor/outdoor fiber optics backbone cables shall have UV resistant cable sheathing and a water blocking material to prevent water intrusion. All outside plant fiber optics backbone cables shall be tested and in compliance with following standards:
 - 1. ANSI/TIA-568-C
 - 2. Telcordia GR-409
 - 3. ANSI/ICEA S-104-696
- C. Jacket: Cable jackets for indoor/outdoor fiber optic cables shall also comply with Article 770 NEC for correct use in the environment in which they will be used. If at the moment of the bid the SCS installer does not know the environment, in which cables will be used, the SCS installer shall assume plenum rated is required for the project. At a minimum all cables shall have a flame retardant riser rated jacket. Rating shall be printed in the cable jacket.
- D. Approved manufacturers. Corning, Belden, Panduit, Siemon, CommScope

2.19 FIBER OPTIC DISTRIBUTION CENTERS

- A. All fiber optic cables shall be terminated in fiber optic distribution centers. Inside premises horizontal fiber optic cables shall be terminated in one side (telecommunication room side) in a fiber optics distribution center (FODC). Backbone fiber optic distribution centers shall be terminated at both ends in a FODC. FODC are composed of an enclosure and snap on adapters. These are the specifications of the enclosures for the FODC:
 - 1. Mounting: Use rack mounted FODC enclosures in all rooms where racks are available or any type of rack rails. Use wall mounted FODC enclosures only when racks are not available like in outdoor enclosures, or other spaces different than telecom rooms.
 - 2. Size: SCS Installer shall size the FODC based on the amount of fiber strands to be terminated in the FODC.
 - 3. Front locking doors are required.

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 121505 Structured Cabling System Section 27 1000 - 13

- 4. Locking door shall be transparent doors and shall have labeling cards.
- 5. Whenever fiber splices are indicated in the design drawings next to an FODC, enclosures shall be selected by the SCS installer as to have spaces to hold splice trays. FODCs under these conditions shall be able to hold the amount of splice trays required for the fiber count indicated in the drawings.
- B. These are the specifications of the snap on adapters for the FODC:
 - 1. Style: plate style cassette style for array connector
 - 2. Connector type: LC to match fiber types of fiber optic cables
 - 3. Maximum fiber strands allowed per adapter: 12
 - 4. Security level: non-keyed connector keyed connector
 - 5. Pairing style: duplex
- C. Approved manufacturers. Corning, Belden, Panduit, Siemon, CommScope

2.20 FIBER OPTICS PATCH CORDS

- A. Fiber optic patch cords shall be required for connections from active equipment to FODCs and/or to telecommunication outlets. Fiber optic patch cords shall be required at both ends of fiber optics backbone cables or horizontal fiber optic cables. Direct connection of backbone cables or horizontal fiber optic cables to active equipment shall not be allowed.
- B. Fiber optic patch cords shall be all factory tested. Field made fiber optic patch cords are not acceptable. The specifications of the fiber optic patch cords shall be:
 - 1. Strand Count: 2 strands
 - 2. Fiber type: Match fiber type of backbone cable or horizontal cable.
 - 3. Fiber connector in FODC or outlet side: match connector for each adapter
 - 4. Fiber connector in active equipment side: the SCS installer shall coordinate with supplier of equipment the type of connector required in this side.
 - 5. Fiber protection: aramid yarn
 - 6. Jacket type: 2.9mm flame-retardant PVC jacket zip-cord type.
 - 7. Color jacket: jacket shall be aqua for OM3 or OM4 fiber and yellow for OS1 or OS2 fiber.
- C. Approved manufacturers. Corning, Belden, Panduit, Siemon, CommScope

2.21 INSIDE PREMISE MULTIPAIR BACKBONE CABLES

- A. Whenever indicated in the drawings multipair backbone cables to be run inside premises and above grade shall have the following specification:
 - 1. Pair count: as indicated in the design drawings
 - 2. Conductor: AWG 24 solid bare copper conductor
 - 3. Input impedance: 100Ω
 - 4. Conductor insulation: color coded thermo plastic
 - 5. Performance requirement: UL verified to ANSI/TIA-568-C Category 5e backbone cable.
- B. Jacket: Cable jacket for inside premise multipair backbone cables shall comply with Article 800 NEC for correct use in the environment in which they will be used. If at the moment of the bid the SCS installer does not know the environment, in which cables will be used, the SCS installer shall assume plenum rated is required for the project. At a minimum all cables shall have a flame retardant PVC jacket riser rated.

- C. Jacket marking: All inside premise multipair backbone cables shall have at least two types of markings imprinted in the jacket, transmission performance marking and NEC rating for environment to be used.
- D. Approved manufacturer: Belden, Superior Essex, General Cable, Berk-Tek or CommScope.

2.22 OUTSIDE PLANT MULTIPAIR BACKBONE CABLES

- A. Whenever indicated in the drawings outside plant multipair backbone cables to be run between buildings or inside premises but below grade shall have the following specification:
 - 1. Pair count: as indicated in the design drawings
 - 2. Conductor: AWG 24 solid bare copper conductor
 - 3. Input impedance: 100 Ω
 - 4. Conductor insulation: Solid polyolefin; color coded in accordance with industry standards.
 - 5. Performance requirement: UL verified to ANSI/TIA-568-C Category 3 backbone cable.
 - 6. Shield: Corrugated, copolymer coated, 8 mil aluminum tape applied longitudinally with an overlap; flooded shield interfaces.
 - 7. Jacket: Black, polyethylene
- B. Jacket: All outside plant multipair backbone cables shall have UV resistant cable sheathing and a water blocking material to prevent water intrusion. All outside plant multipair backbone cables shall be tested and in compliance with following standards:
 - 1. ANSI/ICEA S-84-608-2007
 - 2. RDUP 7 CFR 1755.390 (PE-39)
 - 3. RoHS-compliant
- C. Approved manufacturer: Match selection for inside plant multipair backbone cables.

2.23 TERMINATION OF MUTIPAIR BACKBONE CABLES

- A. Backbone multipair backbone cables for inside premises or outside plant shall be terminated in termination blocks or patch panels. See design drawings for specific types on each case.
- B. Whenever indicated in the design drawings, multipair backbone cables shall be terminated in patch panels. Patch panels for this purpose shall have the following specifications:
 - 1. Connector type: 8-position modular plug (RJ-45)
 - 2. Connector wiring map: One pair per connector pins 4 and 5 (blue pair).
 - 3. Cable termination type: 50-pin connector RJ-21
 - 4. Performance requirement: CAT3
 - 5. Maximum connectors per path panel allowed: 96
 - 6. Permanent marking: All connectors shall be labeled in sequential numbers
 - 7. Field labels: patch panels shall have a space for field labels covered with transparent protectors.
 - 8. Shielding: Unshielded.
- C. Whenever indicated in the design drawings, multipair backbone cables shall be terminated in rack mounted termination blocks. Termination blocks for this purpose shall have the following specifications:
 - 1. Connector type: 110 style connector
 - 2. Cable termination type: IDC type connector
 - 3. Performance requirement: CAT3
 - 4. Rack frame: standard 19" rack.

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

Project No. 121505 Structured Cabling System Section 27 1000 - 15

- 5. Pair counts: use 100 pair blocks for backbone cables under 100 pairs. Use 200 pair blocks in quantities as required for backbone cables with over 200 pairs.
- 6. Wire managers: All 200 pair termination blocks shall have a 2 RU wire manager built-in.
- 7. Clip types: Use 110C4 clips or 110C5 clips.
- 8. Field labels: termination blocks shall have a space for field labels covered with transparent protectors.
- 9. Mounting: termination block shall be mounted without legs in the rack plate.
- D. Whenever indicated in the design drawings, multipair backbone cables shall be terminated in wall mounted termination blocks. Termination blocks for this purpose shall have the following specifications:
 - 1. Connector type: 110 style connector
 - 2. Cable termination type: IDC type connector
 - 3. Performance requirement: CAT3
 - 4. Pair counts: Use only 300 pair blocks in quantities as required for backbone cables.
 - 5. Wire managers: All termination blocks shall have a wire manager installed at both sides of the blocks and between blocks.
 - 6. Clip types: Use 110C4 clips or 110C5 clips for 110 style
 - 7. Field labels: termination blocks shall have a space for field labels covered with transparent protectors.
 - 8. Mounting: termination block shall be mounted with legs on the wall.
- E. Approved manufacturers. Match selection for modular SCS jacks

2.24 SITE COPPER PROTECTORS

- A. General: When required by NEC or when indicated in the drawings copper circuits shall be provided with protection between each building with an entrance cable protector chassis. All building-to-building circuits shall be routed through this protector. Protector shall be connected with a #6 AWG copper bonding conductor between the protector ground lug and the TR ground point.
- B. General: Primary protection units shall be composed of a cabinet that supports 5-pin protection modules and termination blocks. The cabinet for protection unit shall have the following specifications:
 - 1. Capacity: 100 pairs
 - 2. Socket type: 5-pin modules
 - 3. Input mode: 110 style IDC connector.
 - 4. Output mode: 110 IDC
 - 5. Grounding lug capacity: AWG 6 to AWG 14
 - 6. Other: stand-off bracket required.
- C. The protector unit for digital lines shall have the following specifications:
 - 1. Mounting type: 5-pin module.
 - 2. Protection type: Solid state MOV
 - 3. Pairs per unit: one
 - 4. Protection type: heat coil and sneak current protection
 - 5. DC Breakdown Voltage @ 2kV/sec: 60-90 V
 - 6. Surge Breakdown Voltage @100 V /µsec: 220-300 V
 - 7. Insulation Resistance (PE-80): > 100 M Ω
 - 8. DC Holdover Current: 260 mÁ/52 V
 - 9. On-State Voltage @ 75 A: < 10 V
 - 10. Response Time: < 100 nsec
 - 11. Rated Impulse Discharge: 100 A

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 121505 Structured Cabling System Section 27 1000 - 16

TLC Engineering Solutions

- 12. Capacitance(VDC=50 V, f=1 kHz, V AC=1 Vrms): < 100pF
- 13. Line Series Resistance: $< 4 \Omega$
- 14. Sneak Current Operation (heat coils): 540 mA <210 sec, 1 A <15 sec
- 15. Listing: UL 497
- D. The protector unit for analog lines shall have the following specifications:
 - 1. Mounting type: 5-pin module.
 - 2. Protection type: Solid state MOV
 - 3. Pairs per unit: one
 - 4. Protection type: heat coil and sneak current protection balanced
 - 5. DC Breakdown 240 V
- E. Approved Manufacturers for primary protectors: Commscope, Tii, Circa and Emerson
- F. All primary protection block shall be used with a secondary protection block. The secondary protector shall be connected with a #6 AWG copper bonding conductor between the protector ground lug and the TR ground point. Secondary protection shall have the following specifications:
 - 1. Style: Mounted on a 66-type block.
 - 2. Protection type: solid state and fuse protection
 - 3. Pairs per unit: one
 - 4. Breakdown voltage: selected by SCS installer according to signals protected.
 - 5. Maximum number of protectors per block: 25
 - 6. Listing: UL 497A
- G. Approved Manufacturers for secondary protectors: Commscope, Emerson, Siemon

2.25 PATCH CORDS FOR MULTIPAIR BACKBONE CABLES

- A. Patch cords shall be used to connect horizontal wiring to termination blocks for multipair backbone cables. Depending on the type of termination for backbone cables, the patch cord shall be selected.
- B. When multipair backbone cables are terminated in patch panels, patch cords for these patch panels shall have the same specification as the 4-pair patch cord cables described above.
- C. When multipair backbone cables are terminated in wall mounted or rack mounted termination blocks, patch cords shall have a patch plug connector in one end and an 8-pin modular plug (RJ-45) in the other end. The SCS installer shall coordinate with the phone system installer and determine if one pair or two pairs are required for each phone. Patch cords shall have one or two pairs according to the equipment selection. Patch plugs shall only be one or 2 pairs accordingly. Patch plug selection shall match the manufacturer and family of products of the termination blocks.

2.26 EQUIPMENT CABINETS

- A. Whenever indicated in the design drawings equipment cabinets shall be provided as shown. Equipment cabinets shall be made of all welded steel frames and shall have a powder coat finish. Equipment cabinets shall have the following specifications:
 - 1. Cabinet construction material: Welded and bolted steel frame.
 - 2. Footprint: As indicated in the design drawings.
 - 3. Height: Equipment cabinet shall provide a usable height between 44 and 45 RU.

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

TLC Engineering Solutions

Project No. 121505 Structured Cabling System Section 27 1000 - 17

- 4. Rack rails type: standards EIA/ECA 19" square holes with cage nut rail located in the front and back of cabinet. Rack rails shall be adjustable for depth and shall have RU marked and labeled.
- 5. Rack screw type: cage nuts clipped to rack rails. Nuts and screws shall be provided for all slots in rack rails and shall be made of steel threaded as #10-32.
- 6. Side panels (end of row cabinet sides): solid steel, removable and lockable side panels.
- 7. Side panels (between adjacent cabinets): solid steel, removable panels with openings for passing cables, covered with plastic removable caps, rubber caps or brush openings. No less than Eight (8) openings in total area of the side of the cabinet. Each opening shall be no less than 34 sq inches.
- 8. Top panel: solid steel with no less than four (4) brush protected openings for cables. Each opening shall be no less than 34 sq inches.
- 9. Bottom panel: solid steel with no less than two (2) brush protected openings for cables. Each opening shall be no less than 34 sq inches. For cabinets with top exhaust duct, a bottom air director shall be provided in the back side of the cabinets to force air up towards the exhaust duct.
- 10. Door hinge supports shall be provided at both sides of the racks and front and back to be able to reverse doors.
- 11. Grounding: Prepared location for ground lug at the top and bottom of the cabinet frame. Door shall include bonding jumper to cabinet.
- 12. Weight capacity: UL listed for 2500 lb
- 13. Finish: Epoxy-polyester hybrid powder coat paint on frame, rails, panels and metal accessories:
- 14. Finish color: Black for all parts of the cabinet
- B. Equipment cabinets shall be provided with the following accessories:
 - 1. Front 78% perforated panel hinged door with key lock.
 - 2. Rear 78% perforated panel solid split hinged doors with lock.
 - 3. Locking system: locks for front and rear doors shall be two point latching locks and shall be keyed identically for front and rear lock. All locks for cabinets for each user ground shall be keyed alike but different between user groups.
 - 4. Leveling feet and any accessories required to be able to bolt the cabinet to the floor with $\frac{1}{2}$ " screws or rods. Four (4) casters are required.
 - 5. Vertical wire managers covering the full height of the rack rails. Two in the front. Vertical wire managers shall be selected as recommended by equipment cabinet manufacturer to avoid obstructions to rack rails or doors. Vertical wire managers shall have brush openings to run cables between front and back of cabinet and shall have all openings sealed to avoid air leakage between front and back.
 - 6. Steel top exhaust duct, made of two separate sections to allow adjusting the height. Installer shall confirm final ceiling height in the room and order these ducts in a length as to provide adjustment for no less than 2" above and below of the final ceiling height. Top exhaust section shall have a rubber gasket to allow for good seal in ceiling imperfections.
 - 7. Filler panels: For all racks with SCS installer provided equipment, all un-used rack spaces shall be covered with filler panels to avoid any air flow between front and back of cabinet. For all racks with owner provided equipment, the installer shall provide no less than 50% of all rack spaces in all racks with filler panels to prevent air flow between front and back of cabinet. All cabinets with no equipment installed at the end of the project shall have the front door wrapped with plastic wrap to prevent any air flow through the cabinet.
 - 8. Air dam: The cabinet shall be provided with an air dam blocks airflow around the sides and top of the equipment mounting space, so cold air passes through equipment and hot air does not re-circulate around equipment. Any other additional type of seal required to prevent air flow from the front of the cabinet to the back shall be provided.
 - 9. PDU bracket: PDU brackets shall be provided in each cabinet according to the number of vertical PDUs programmed to be installed in each cabinet. See drawings for quantities.

These brackets shall be selected by the SCS installer as to match the support holes of the PDU selection for each cabinet.

- 10. All cabinets with equipment installed with substantial amount of cables terminating in the rear of the equipment, such as audio/visual systems and security systems shall be provided with enough cable lashing metal brackets to strap all cables to the frame for proper organization and support.
- 11. Ground bar: all cabinets shall be provided with a copper vertical ground bar covering the complete length of the rack rails. The ground bar shall be 1/8" thick and 1" wide with threated holes 1032 mounted to the cabinet using nylon insulation washers
- C. Required equipment cabinet certifications: Complaint with EIA/ECA 310-E and UL 2416 listed
- D. Airflow re-director: The manufacturer of the equipment cabinet shall offer an air flow re-director kit for the type of cabinet selected for this project to allow for changing air flow direction of equipment designed for side to side ventilation. The SCS installer shall provide air flow re director kits for all cabinets in the plans with Core switches or network equipment.
- E. Field cuts or openings. Any cabinets with field cuts or perforations will be rejected and the SCS installer shall provide a new cabinet to remedy the condition.
- F. Approved manufacturer: Panduit, Ortronics, Eaton, Belden, Middle Atlantic Products, Great Lakes, Chatsworth Products Inc. or approved equal.

2.27 QUAD POST RACKS

- A. Whenever indicated in the design drawings quad post racks shall be provided as shown. Quad post racks shall be made of aluminum or welded steel frames and shall have a powder coat finish. Quad post racks shall have the following specifications:
 - 1. Depth adjustment: rack rails shall be adjustable from 12.5" to 36" in depth, independent of the structural members allowing racks rails adjustment after racks are anchored.
 - 2. Height: Equipment cabinet shall provide a usable height between 44 and 45 RU.
 - 3. Rack rails type: standards EIA/ECA 19" square holes located in the front and back of rack. Rack rails shall have RU marked and labeled.
 - 4. Rack screw type: cage nuts clipped to rack rails. Nuts and screws shall be provided for all slots in rack rails and shall be made of steel threaded as #10-32.
 - 5. Weight capacity: UL listed for 1200 lb or more.
- B. Quad post racks shall be provided with the following accessories:
 - 1. Base dust covers that prevent accumulation of dust and debris in rack base.
 - 2. Cable runway mounting brackets to support cable runway installed above racks
 - 3. Isolation pads.
 - 4. Grounding kit.
 - 5. Ground bar: all cabinets shall be provided with a copper vertical ground bar covering the complete length of the rack rails. The ground bar shall be 1/8" thick and 1" wide with threated holes 1032 mounted to the cabinet using nylon insulation washers
 - 6. End panels to support vertical wire managers at the end of each rack row.
- C. Front vertical wire managers shall be provided in between all racks and at both ends of rack rows covering from top to bottom of each rack. The specifications of those wire managers shall be:
 - 1. Style: Metal cage with dual hinged door cover
 - 2. Sides: single sided wire manager (front only).
 - 3. Capacity: Usable cross sectional area shall be minimum of: 130 sq-in

Project No. 121505 Structured Cabling System Section 27 1000 - 19

- 4. Accessories: whenever cable manager supports the use of spools inside the unit, spools shall be provided at all locations in the unit.
- D. Rear vertical wire managers shall be provided in between all racks and at both ends of rack rows covering from top to bottom of each rack. The specifications of those wire managers shall be:
 - 1. Style: Metal cage with dual hinged door cover
 - 2. Sides: single sided wire manager (rear only).
 - 3. Capacity: Usable cross sectional area shall be a minimum of: 130 sq-in
 - 4. Accessories: whenever cable manager supports the use of spools inside the unit, spools shall be provided at all locations in the unit.
- E. Approved manufacturer: Panduit, Ortronics, Belden, Middle Atlantic Products, Great Lakes, Chatsworth Products Inc. or approved equal.

2.28 TWO POST RACKS (CHANNEL RACKS)

- A. Whenever indicated in the design drawings two post racks shall be provided as shown. Two post racks shall be made of aluminum or welded steel frames and shall have a powder coat finish. Two post racks shall have the following specifications:
 - 1. Height: Equipment cabinet shall provide a usable height between 44 and 45 RU.
 - 2. Channel depth: 3"
 - 3. Rack rails type: standards EIA/ECA 19" located in the front and back of rack. Rack rails shall have RU marked and labeled.
 - 4. Rack screw type: #12-24 threaded rack rails. Screws shall be provided for all openings in rack rails and shall be made of steel.
 - 5. Weight capacity: UL listed for 1000 lb or more.
- B. Two post racks shall be provided with the following accessories:
 - 1. Cable runway mounting brackets to support cable runway installed above racks
 - 2. Isolation pads
 - 3. Grounding kit.
 - 4. Ground bar: all cabinets shall be provided with a copper vertical ground bar covering the complete length of the rack rails. The ground bar shall be 1/8" thick and 1" wide with threated holes 1032 mounted to the cabinet using nylon insulation washers
 - 5. End panels to support vertical wire managers at both ends of each rack row.
- C. Front vertical wire managers shall be provided in between all racks and at both ends of rack rows covering from top to bottom of each rack. The specifications of those wire managers shall be:
 - 1. Style: Metal cage with dual hinged door cover cage with latches or finger-duct with removable covers
 - 2. Sides: dual side wire manager.
 - 3. Capacity: Usable cross sectional area shall be minimum of: 130 sq-in
 - 4. Accessories: whenever cable manager supports the use of spools inside the unit, spools shall be provided at all locations in the unit.
- D. Rear vertical wire managers shall be provided in between all racks and at both ends of rack rows covering from top to bottom of each rack. The specifications of those wire managers shall be:
 - 1. Style: Metal cage with dual hinged door cover
 - 2. Sides: single sided wire manager (rear only) or if dual side wire front managers are included, no need for rear vertical wire managers.
 - 3. Capacity: Usable cross sectional area shall be minimum of: 130 sq-in

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

 Project No. 121505

 Structured Cabling System

 TLC Engineering Solutions
 Section 27 1000 - 20

- 4. Accessories: whenever cable manager supports the use of spools inside the unit, spools shall be provided at all locations in the unit.
- E. Approved manufacturer: Panduit, Ortronics, Belden, Middle Atlantic Products, Great Lakes, Chatsworth Products Inc. or approved equal

2.29 WALL MOUNTED RACKS

- A. Whenever indicated in the drawings, wall mounted racks shall be provided as indicated. Wall mounted racks shall be made of aluminum or welded steel frames and shall have a powder coat finish. Wall mounted racks shall have the following specifications:
 - 1. Style: Swing out reversible cabinet
 - 2. Height: As indicated in design drawings.
 - 3. Depth: it is the responsibility of the SCS installer to select a cabinet that will fit all equipment to be installed in the racks, either provided under this contract or by the owner. Approval of submittals by the A&E does not relief the SCS installer of the responsibility of verifying this requirement. Racks that will not fit the equipment shall be replaced at no additional cost to the owner.
 - 4. Rack rails type: standards EIA/ECA 19" located in the front. Rack rails shall be adjustable and shall have RU marked and labeled.
 - 5. Rack screw type: #12-24 threaded rack rails. Screws shall be provided for all openings in rack rails and shall be made of steel.
 - 6. Weight capacity: UL listed for 200 lb or more.
- B. Wall mounted racks shall be provided with the following accessories:
 - 1. Front perforated panel door with lock. Door shall be hinged and shall be reversible.
 - 2. Fan kit composed of two 4" fans and fan guards.
 - 3. Additional rack rails shall be provided when equipment with a different of 2" in front depths are to be mounted in the rack. Front depth is defined as the distance between the front of the rack ears and the front of the equipment, including space for connectors or bend radius of cables.
 - 4. Grounding kit.
 - 5. Ground bar: all cabinets shall be provided with a copper vertical ground bar covering the complete length of the rack rails. The ground bar shall be 1/8" thick and 1" wide with threated holes 1032 mounted to the cabinet using nylon insulation washers.
- C. Approved manufacturer: Panduit, Ortronics, Belden, Middle Atlantic Products, Great Lakes, Chatsworth Products Inc. or approved equal.

2.30 MEDIA CONVERTERS

- A. General. When telecommunications outlets exceed distance limitations to pass testing requirements, the SCS installer shall provide media converters and fiber optics connectivity to overcome this problem. The media converters shall have the following specifications:
 - 1. Power: All power for media converters in the field end (i.e. camera or WAP side) shall be powered from the Telecom room side using a hybrid cable. Local power adapters for media converters are not acceptable in the field end.
 - 2. Cabling: A composite cable shall be used for these devices. This composite cable shall have a minimum of 2 strands of fiber optics and 1 pair of copper cable AWG-12 for the remote end power. The quantity of fiber strands for this cable shall be as required by the type of media converter used. The fiber types shall be as required by the media converter. The cable jack for this composite cable shall be selected as required for the application. Any cables being pulled underground shall have a water blocking jacket.

- 3. Port count: Media converters with 1 port or 4 ports are acceptable.
- 4. PoE support: Media converters shall support PoE without the need of an external power adapter and the field end.
- 5. Fiber connection speed. Media converters shall support 1GB connections in the fiber port.
- 6. PoE capacity: Media converters shall support PoE+ (30W) for all outdoor cameras and all WAPs. Media converter shall support 15,4 W for all other PoE devices.
- 7. Power supplies: Media converters shall be provided with the corresponding power supplies at the telecom room.

2.31 CABLE TIES

- A. Cable ties shall be used at different locations of the project but with the same goal of producing a neat and organized installation. Cable ties shall be used to support cables to j-hooks (when jhooks are allowed in the project) to organize cables in ladder trays, D-rings and cable trays, to support cables to wire managers including managers behind patch panels, to bundle cables, organize patch cords, etc.
- B. To support and organize all horizontal cabling and inside premise backbone cables, only the following types of cable ties shall be used:
 - 1. Hook and loop style, re-usable with Velcro no smaller than 0.5" width.
 - 2. Pre-perforated rolls of re-usable ties with Velcro no smaller than 0.5" width
 - 3. Straps of other soft materials with cinch rings that allow for re-use of the cable ties in widths no smaller than 0.85".
- C. Nylon based cable ties (re-usable or not) can only be used to support and organize the following types of cables:
 - 1. Outside plant fiber and copper backbone cables.
 - 2. Inside premise fiber optic backbone cables with interlock armors.
 - 3. Grounding conductors
- D. Nylon based cable ties shall never be used to support or organize any type of horizontal cables or inside premise fiber optic backbone cable without armor.
- E. All cable ties to be used in outdoor environments shall be made of weather resistant Acetal. Outdoor cable ties used for aerial cable lacing shall be in compliance with Telcordia TR-TSY-000789 standard.
- F. All cable ties shall be selected in lengths as to properly secure the bundle of cable being supported.
- G. All cable ties to be used in air handling spaces, such as above ceiling and under raised floor areas, shall be UL listed for the use in those environments.
- H. Approved manufactures: Ortronics, Panduit or approved equal

2.32 IDENTIFICATION AND LABELING TAGS

A. SCS installer shall follow labeling materials indicated in specification section 270010.

PART 3 - EXECUTION

3.1 INSTALLATION PRACTICES.

- A. GENERAL. All installation requirements indicated in specification section 270010 shall be followed.
- B. WORKMANSHIP. All work shall be completed by the SCS installer in a neat and workmanlike manner. The use of all BICSI standards and recommendations for installation shall be followed as the benchmark for workmanship.
- C. CABLE LENGTHS. It is the SCS installer's responsibility to plan the cable routing in the cable tray and other raceways as to minimize all cable runs to be able to stay under the 90 meter (295 ft) length limitation for Horizontal Cabling. All cable runs exceeding the wiring distance, due to raceways run in not the most efficient way to minimize distance, shall be re-run with horizontal fiber optic cables and with media converters, at no extra cost to the owner.
- D. WIRE MAPPING. All terminations of 4-pair horizontal cabling in this project and terminations of all 4-pair patch cords shall be per T568B standard.
- E. FIBER OPTICS TERMINATION POLARITY. All fiber optic cables (horizontal or backbone) terminated in duplex style adapter panels shall be connected in a cross-over polarity configuration. As an example, if fibers 1 and 2 are terminated in one end in positions A and B respectively in one side of the cable, the same strands shall be terminated in B and A positions in the other side of the cable.
- F. POLARITY FOR FIBER OPTICS ARRAY CONNECTORS. Array connectors and cassettes for this project shall use Method C polarity system as outline in TIA-568.B.1
- G. LOCATION OF HORIZONTAL TERMINATIONS. In a multi-story facility with telecommunications room in every floor, all horizontal drops, whether terminated in the wall or in floor boxes shall be terminated in the same floor telecommunications room as the location of the final outlet.
- H. CABLE BUNDLES. In suspended ceiling and raised floor areas if duct, cable trays or conduits are shown on the contract drawings, the SCS installer shall bundle, in bundles of 40 or less, horizontal wiring with cable ties snug, but not deforming the cable geometry. The cable bundling shall be supported via "CLIC" fasteners in TR's and non-plenum areas and J-hooks in ceiling spaces. The SCS installer shall adhere to the manufacturers' requirements for bending radius and pulling tension of all cables.
- I. CLIC FASTENERS: Horizontal cables shall be suspended by "CLIC" fasteners with cable inserts in TR's on the plywood area where ladder tray or rack management is not available per the design documents. Listings: "CLIC" fasteners shall be in accordance with NEC and BICSI standards. Above the plywood area J-hooks or D-rings should be used.
- J. FIRE STOP PROTECTION: Sealing of openings between floors, through rated fire and smoke walls, existing or created by the SCS installer for cable pass through shall be the responsibility of the SCS installer. Sealing material and application of this material shall be accomplished in such a manner, which is acceptable to the local fire and building authorities having jurisdiction over this work. Creation of such openings as are necessary for cable passage between locations as shown on the drawings shall be the responsibility of the SCS Installer's work. Any

openings created by or for the SCS installer and left unused shall also be sealed as part of this work. Penetration rating shall equal structure rating.

- K. NEW MATERIALS: All components, wiring and materials to be used for the installation of the SCS shall be new and free of defects. Used components, wiring and materials shall only be used when specifically indicated in the design drawings.
- L. DAMAGE: The SCS Installer shall be responsible for any damage to any surfaces or work disrupted as a result of his work. Repair of surfaces including painting and ceiling tile replacement shall be included as part of this contract.
- M. AVODING EMI: To avoid EMI, all pathways shall provide clearances of at least 4 feet (1.2 meters) from motors or transformers; 1 foot (0.3 meter) from conduit and cables used for electrical-power distribution; and 5 inches (12 centimeters) from fluorescent lighting. Pathways shall cross perpendicular to fluorescent lighting and electrical-power cables and conduits. The SCS installer shall not place any distribution cabling alongside power lines, or share the same conduit, channel or sleeve with electrical apparatus.
- N. WORK EXTERNAL TO THE BUILDING: Any work external to the confines of this building as shown on the drawings shall be governed by the provisions of this specification.
- O. DEMOLITION. Any task part of the installation of the SCS requiring relocation, rerouting and/or demolition shall be done according to the following requirements:
 - 1. Coordination: Prior to any deactivation and relocation or demolition work, arrange a conference with the Architect and the Owner's representative in the field to inspect each of the items to be deactivated, removed or relocated. Care shall be taken to protect all equipment designated to be relocated and reused or to remain in operation and be integrated with the new systems.
 - 2. Provisions: All deactivation, relocation, and temporary tie-ins shall be provided by the SCS installer. All demolition, removal and the legal disposal of demolished materials of system designated to be demolished shall be provided by the SCS installer.
 - 3. All Existing Voice/Data cables and connecting hardware not to be used after the new installation is complete and within the areas where work is required as part of this project shall be removed by the SCS installer. All existing cables to be left for future use if indicated by the owner shall be tagged for that purpose.
 - 4. Owners Salvage: The Owner reserves the right to inspect the material scheduled for removal and salvage any items he deems usable as spare parts.
 - 5. Phasing: The SCS installer shall perform all work in phases as directed by the Architect to suit the project progress schedule, as well as the completion date of the project.
- P. ICONS. Faceplates, jacks or patch panels with inserts for icons shall be filled with icons when unit capable of accepting icons. Icons in the work area side (outlet) shall match the color of the RJ-45 modular jack. Icons for path panels shall match the color of the horizontal cabling.
- Q. BLANK INSERTS AND PANELS. All telecommunications outlets with faceplates or mounting frames with unused terminations shall be plugged with blank inserts or panels. Blank inserts shall match the color of the faceplate or mounting frame. No more than one blank module shall be required for each faceplate. All unused ports in the FODC enclosures for adapter panels shall be filled with blank adapter panels.
- R. PATCH PANEL AND FODC SEPARATION: Horizontal cables shall be terminated in separate patch panels according to the use of the cable. Each series of patch panels or FODC for a specific use shall have at least 20% spare capacity of ports. Patch panels of the same use shall be mounted consecutive in the equipment cabinets or racks. The following separation for patch panels and FODCs shall be provided:

- 1. Cables for Wireless Access Points (WAPS) shall be separated from cables for any other purpose.
- 2. Cables for surveillance cameras shall be separated from cables for any other purpose.
- 3. Cables for voice drops shall be separated from cables for data drops.
- 4. Cables for any other specialty systems like security systems, nurse call systems or others shall all be terminated in separate patch panels from any other cables.
- 5. Horizontal fiber optic cables shall be terminated in separate FODC from fiber optics backbone cables.
- 6. Single mode fiber optic backbone cables shall be terminated in separate FODC from multimode fiber optic backbone cables.
- S. SUPPORTS FOR REAR OF PATCH PANELS. All patch panels for horizontal cables shall be provided with a rear support bar to hold the cable and to provide strain relief. At a minimum one rear support bars shall be provided for each two rows of 24 connectors.
- T. HORIZONTAL WIRE MANAGERS. Horizontal wire managers shall be provided following this criteria:
 - 1. At least one above and below each straight (flat) patch panel.
 - 2. At least one top and bottom of each series of angled or curved patch panels.
 - 3. At least one above and below any network switches.
 - 4. At least one below any rack mounted termination block.
- U. CROSS OVER WIRE MANAGERS. Cross over wire managers shall always be used with angled or curved patch panels. One cross over wire manager shall always be installed in the middle of each rack at the same height on every rack.
- V. PATCH CORD QUANTITY, COLOR AND LENGTHS. Copper and fiber optics patch cords shall be provided per following chart. All percentage calculations shall be rounded off to the nearest integer number.

TYPE	QTY	COLOR JACKET	LEGTH
4-pair at work area	One for 90% of all 4-pair	Match horizontal	30% 8', 50% 10' and 20%
outlet	horizontal cables in the	cable color jacket	14'
	project	specified.	
4-pair at WAP	One for 100% of all 4-pair	Match horizontal	The SCS installer shall
location	horizontal cables for	cable color jacket	field verify all lengths to
	WAPS in the project +	specified.	match location of WAPS
	10% spare		selected by owner or
			wireless survey. For
			pricing purposes use 12'
4-pair at Surveillance	One for 100% of all 4-pair	Match horizontal	The SCS installer shall
camera	horizontal cables for	cable color jacket	field verify all lengths to
	cameras in the project	specified.	match location of
	+10%		cameras. For pricing
			purposes use 12'
4-pair at patch panel	One for 90% of all 4-pair	Match horizontal	For pricing purposes use:
side (excluding	horizontal cables in the	cable color jacket	40% 6', 40% 8', 20% 12'.
surveillance cameras	project	specified.	SCS installer shall field
and WAPS)		•	verify these percentages
			to provide more accuracy.
4-pair at patch panel	One for 100% of all 4-pair	Match horizontal	For pricing purposes use:
side (surveillance	horizontal cables in the	cable color jacket	40% 6', 40% 8', 20% 12'.
cameras and WAPS)	project +10%	specified.	SCS installer shall field
			verify these percentages
			to provide more accuracy.

2-strand fiber optics at work area outlet	One for 100% of all 2- strand horizontal fiber cables in the project + 10% spare	Per fiber type	50% 8' and 50% 10'
2-strand fiber optics at FODC.	One for 100% of all horizontal 2-strand fiber cables and one for 83% of all fiber strands of backbone cables in the project. For example a 24 strand cable shall require 20-2-strand patch cords or 10 for each side of the cable	Per fiber type	For pricing purposes use: 20% 6', 60% 10'. 20% 14' SCS installer shall field verify these percentages to provide more accuracy.
One or two pair for copper backbone cross connects	One for 90% of all backbone copper pairs installed in the project.	Gray	For pricing purposes use: 80% 8', 20% 10'. SCS installer shall field verify these percentages to provide more accuracy.

- W. CABLE SLACK. Cable slack shall be provided for all cables in the project following this guideline:
 - 1. At each work area outlets, all horizontal cables shall have 12" of slack.
 - 2. At the telecom room side all horizontal cables shall have at least 6' neatly organized on the wall using a figure 8 configuration or a non-loop shaped arrangement with Velcro straps.
 - 3. Backbone cables at termination points shall have at least 15' of slack neatly organized on the wall using a standard loop and Velcro straps.
 - 4. Outside plant backbone cables run through in-ground pull boxes greater than 24"X24" shall include one service loop inside the box.
- X. BEND RADIUS. Installation of Fiber Optic Cables shall be in accordance with ANSI/TIA-568C guidelines and cable manufacturer specifications. Bend radius parameters shall be followed for load and no load conditions. Cable installation and terminations that do not comply shall be replaced by the SCS installer. If no recommendation is specified by cable manufacturer, at least the following criteria shall be meet:
 - 1. The bend radius for intrabuilding 2 and 4-fiber horizontal optical fiber cable shall not be less than 25 mm (1 in) under no-load conditions. When under a maximum tensile load of 222 N (50lbf), the bend radius shall not be less than 50 mm (2 in).
 - 2. The bend radius for intrabuilding optical fiber backbone with fiber counts above 4 shall not be less than 10 times the cable outside diameter under no-load conditions and no less than 15 times the cable outside diameter when the cable is under tensile load.
 - 3. The bend radius for interbuilding optical fiber backbone shall not be less than 10 times the cable outside diameter under no-load conditions and no less than 20 times the cable outside diameter when the cable is under tensile load up to the rating of the cable, usually 2670 N (600lbf).
- Y. INNERDUCT. Innerduct shall be provided from end to end of a raceway system under the following conditions:
 - 1. Inside underground conduits as indicated in design drawings.
 - 2. For horizontal fiber optic cable or inside premise fiber optics backbone cables without interlocking armor when routed through cable trays, ladder trays, vertical conduit sleeves or conduits larger than 3". This requirement is usually not indicated in the drawings but indicated only in this specification.

- Z. SCS PROTECTION DURING CONSTRUCTION. The SCS installer shall protect all SCS materials from damage during construction. Racks shall be covered with fabric or plastic after mounting to prevent dust, debris and other foreign materials having contact with SCS devices. The SCS installer shall protect at all times all fiber optic and copper cables from damage during installation. All cables shall maintain the physical integrity as manufactured for testing and delivery to the owner. All damaged cables shall be replaced at no additional cost to the owner.
- AA. CABLE BONDING. Shielded cables or cables with metal strength or protection members (like interlocking armor) shall be bonded to the telecommunications grounding system as indicated in specification section 270526.
- BB. RACK INSTALATION. All racks shall be installed leveled and plumbed. Four post racks and two post racks shall be anchored to the floor and shall be installed with isolation pads. Equipment cabinets shall be leveled using the leveling feet unless design drawings specifically indicate to leave them on the casters.
- CC. RACK BONDING. All equipment cabinets and racks shall be bonded to the telecommunication grounding system as indicated in specification section 270526

3.2 IDENTIFICATION AND TAGGING

- A. General: Identification and tagging of SCS components shall be executed by the SCS installer. At a minimum identification and tagging shall be provided for the following components of the system:
 - 1. All horizontal and backbone cables at both ends of the cable in the cable jacket. Labels on each side shall be different indicating the location of the other side of the cable
 - 2. All faceplates indicating all jacks terminated in the faceplate.
 - 3. All patch panels.
 - 4. All racks
 - 5. All termination blocks
 - 6. All telecommunication rooms and outdoor enclosures.
 - 7. All interbuilding backbone cables inside in ground pull boxes outside of the building shall have a visible label in each box they pass through.
- B. The SCS installer shall follow the owner provided identification system. If owner does not have any preference or standard the SCS installer shall provide a system for approval of the A&E and the owner as indicated in the submittal paragraph of this specification. The identification system shall follow the ANSI/TIA 606-C standard.

3.3 TESTING OF COPPER CABLING

- A. General: Horizontal and backbone cabling shall be verified in accordance with ANSI/TIA-568-C, Cabling Transmission Performance and Test Requirements.
- B. For all 4-pair copper cabling terminated for the use of building systems or system provided under the contract, such as surveillance cameras, emergency phones, elevator phones, WAPs, Access control panels and building automation equipment, the required test shall be a Channel style test. This means copper test shall be done with patch cords that will be used for permanent installation of those devices.

- C. For all 4-pair copper terminated for the use in work areas such as computers and phones, the test method selected for all 4-pair copper cabling is a permanent link style test. Permanent link test is defined as a test that does not include the patch cords to be used in the project.
- D. General: In the event the A&E elects to be present during the tests, provide notification to the engineer two weeks prior to testing.
- E. General: The installer's RCDD shall sign off on all copper and fiber optic cable test results, indicating that he/she was in responsible charge of all cable testing procedures and that all cables were tested in compliance with the contract documents and met or exceeded the requirements stated herein.
- F. Testing Equipment: Tester shall be as manufactured by Agilent, Fluke, IDEAL or Wavetek. Tester shall be 100% Level IIIe compliant with ANSI/TIA 568C specifications for testing of the CAT6A cabling. No tester will be approved without meeting these requirements.
- G. Each jack in each outlet shall be tested at a minimum to the manufacturer's performance of the cable to verify the integrity of all conductors and the correctness of the termination sequence. Testing shall be performed between work-areas and the equipment rack patch panel. Prior to testing UTP runs, the tester shall be calibrated per manufacturer guidelines. The correct cable NVP shall be entered into tester to assure proper length and attenuation readings.
- H. Documentation of cable testing shall be required. The SCS installer shall provide the results of all cable tests in electronic format (final results in PDF format and raw data). Each test page shall be separated by standard page break (one test per page). The test results shall include: sweep tests, continuity, polarity checks, wire map, Attenuation, NEXT, PSNEXT, FEXT, PSFEXT, ELFEXT, PSELFEXT, ACR, Return Loss, Delay Skew, and the installed length. Cables not complying with the ANSI/TIA 568C tests results shall be identified to the A&E for corrective action which may include replacement at no additional expense to the Owner. All identification names of the cables used in the test shall match the labeling system approved for the project and the corresponding shop drawings.
- I. Any Fail, Fail*, Pass* or WARNING test result yields a Fail for the channel or permanent link under test. In order to achieve an overall Pass condition, the result for each individual test parameter must be passed. All test results shall come from a tester with the permanently enabled marginal reporting feature.
- J. Test results shall show and comply with the margin claimed by the manufacturers over CAT6 CAT6A permanent link specifications on all transmission parameters across the entire frequency range as shown on the manufacturer's cut sheets.
- K. General: Copper multipair backbone cabling shall be tested for length, continuity, polarity checks and wire map. The SCS Installer shall provide the results of all Copper Riser cable tests in electronic format. The use of pigtails or special harness could be required to properly test these cables.
- L. Trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof shall execute the tests.
- M. All 4-pair patch cords shall be factory tested only.

3.4 TESTING OF FIBER OPTICS CABLING

- A. General: Horizontal and backbone cabling shall be verified in accordance with ANSI/TIA 568-C and the addendum for fiber optic testing.
- B. General: In the event the Engineer elects to be present during the tests, provide notification to the engineer two (2) weeks prior to testing.
- C. Cleanness: All fiber optics connector shall be cleaned properly before any testing and after testing. Proof of cleanness shall be required during the acceptance test for the SCS by the A&E. SCS installer shall have available during this test a 200X microscope or a video probe to demonstrate the cleanness of the randomly selected connectors by the A&E.
- D. End to End Attenuation Test: The SCS installer shall perform end-to-end attenuation testing for each multimode fiber at 850 nm and 1300 nm from both directions for each terminated fiber span in accordance with ANSI/TIA-526-14A (OFSTP 14) and single-mode fibers at 1310 nm and 1550 nm from both directions for each terminated fiber span in accordance with ANSI/EIA-526-7 (OFSTP 7). A one jumper reference shall be used for all testing. For spans greater than 90 meters, each tested span must test to a value less than or equal to the value determined by calculating a link loss budget. For horizontal spans less than or equal to 90 meters, each tested span must be < 2.0 dB. When calculating the link loss budget for spans greater than 90 meters use the values listed below. End to end attenuation shall be done with a Level II meter using a meter and light source equipment (also known as main and remote unit)</p>

ATTENUATION DUE TO	FIBER TYPE	MAX. ATTENUATION
Terminating connectors. Field terminated options	All fiber types	0.75 dB per connector
Terminating connectors, pre- term fibers	All fiber types	No more than 0.2 dB additional to total dB loss measured at the factory in report sent by cable manufacturer.
Splices	All fiber types	0.3 dB per splice
Distance	OM1 (850nm/1300)	3.4 dB /1.0 dB per Km.
Distance	OM2, OM3 and OM4 (850nm/1300)	3.0 dB /1.0 dB per Km.
Distance	OS1 and OS2 (1310 nm/1383 nm/1550 nm)	0.65 dB /0.65 dB/ 0.5 dB per Km.

- E. OTDR Test. Additional to end to end attenuation test, all fiber optic cables shall be tested with a Level III OTDR equipment for the following conditions:
 - 1. Each known event (connector/splice) insertion loss at both windows for each fiber type (850/1300 nm for multimode and 1310/1550 nm for single mode). All events shall pass maximum allowed insertion loss for the event type as indicated in table above.
 - 2. Reflective events (connections) shall not exceed:
 - a. 0.75 dB in optical loss when bi-directionally averaged
 - b. -35 dB Reflectance for multimode connections
 - c. -40 dB reflectance for UPC singlemode connections
 - d. -55 dB reflectance for APC singlemode connections
 - 3. Non-reflective events (splices) shall not exceed 0.3 dB.
 - 4. Estimated distance for multiple strands of the same cable shall not vary more than 1% between strands.
 - 5. Cable signature in the form of traces along the complete distance of the cable. Unexplained cable reflections shown in the OTDR shall require the installer to submit letter explaining such events and pictures of cable conditions in the locations where the

unexplained events are located to demonstrate cable has not been kinked or damaged during installation.

- F. OTDR Test conditions. All OTDR testing shall be performed with the following conditions:
 - 1. Use a launch cable and a tail cable in accordance with fiber type being tested and requirements indicated by OTDR equipment manufacturer.
 - 2. Launch and tail cables shall be products sold by testing equipment manufacturer and not field made cables.
 - 3. Launch and tail cables shall be selected according to the type of connector being tested such as APC or UPC type connectors.
 - 4. Use launch compensation mode during the test to subtract the effects of the launch and tail cables.
 - 5. Test from one direction only, unless the presence of "gainers" are spotted during the test. In such case the installer shall test in both directions and adjust the test equipment to average measurements from both directions.
 - 6. The SCS installer shall verify the backscatter coefficient use in the test to make sure it matches the coefficient of the cable being tested.
- G. OTDR Testing Equipment used on this project shall have the specifications indicated in this following table:

SPECIFICATION	MULTIMODE	SINGLE MODE
Wavelengths	850 nm ±10 nm	1310 nm ±25 nm.
	1300 nm +35 / -15 nm.	1550 nm ±30 nm.
Event Dead Zone. Measured at 1.5 dB below non-saturating reflection peak with the shortest pulse width. Reflection peak < -40 dB for mm and < -50 dB for sm.	850 nm: 0.5 [3.7] m typical 1300 nm: 0.7 [3.5] m typical	1310 nm: 0.6 [3.5] m typical 1550 nm: 0.6 [3.5] m typical
Attenuation Dead Zone. Measured at ± 0.5 dB deviation from backscatter with the shortest pulse width. Reflection peak < -40 dB for mm. and < -50 dB for sm.	850 nm: 2.2 [10] m typical 1300 nm: 4.5 [13] m typical	1310 nm: 3.6 [10] m typical 1550 nm: 3.7 [12] m typical
Pulse Widths (nominal)	850 nm: 3, 5, 20, 40, 200 ns. 1300 nm: 3, 5, 20, 40, 200, 1000 ns.	3, 10, 30, 100, 300, 1000, 3000, 10000, 20000 ns
Loss Threshold Setting	0.01 dB to 1.5 dB Adjustable in 0.01 dB increments	0.01 dB to 1.5 dB Adjustable in 0.01 dB increments

- H. The Test Report for each fiber strand shall include the following information:
 - 1. Calculated Loss Budget for each optical fiber link (see attenuation table above)
 - 2. Cable/strand ID matching shop drawings labeling system.
 - 3. Name of technicians who performed the test.
 - 4. Date and time the test was performed.
 - 5. Measurement direction (from/to)
 - 6. Jumper reference set up date/time and attenuation value
 - 7. Equipment model and serial number used and calibration date.
 - 8. End to End Attenuation Loss Data for each optical fiber link
 - 9. OTDR Traces, one page per strand. Expand chart to cover most of the page
 - 10. Each event loss data and test limits used, including test limit file date used.

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

TLC Engineering Solutions

Project No. 121505 Structured Cabling System Section 27 1000 - 30 I. For fiber optic cables with factory terminated connectors or pre-terminated pig-tails, The SCS installer shall provide also the test results performed at the factory for fiber optic cables with factory terminated connectors to compare with the field test done by the SCS installer. No significant variation between the factory test results and the field test results shall be encountered.

3.5 SYSTEMS WARRANTY AND SERVICE

- A. SCS Installer shall follow all warranty and service requirements indicated in specification section 270010.
- B. Warranty: The SCS shall be required to be under the manufacturer's warranty program for a complete channel configuration including cable, jacks, patch cords and patch panels and include cabling specifically approved for the channel configuration with the manufacturer's components. Manufactures shall provide the warranty worst-case performance data for the installed cabling system, and the performance data indicated in the warranty documents/certificate.
- C. A twenty five (25) year warranty available for the Structured Cabling System (Fiber optics and copper infrastructure) shall be provided for an end-to-end channel model installation which covers applications assurance, cable, connecting hardware and the labor cost for the repair or replacement thereof.
- D. Additional features of the warranty shall include:
 - 1. That the SCS installed system complies with the margin claimed by the manufacturer above the category 6A channel specifications on all transmission parameters across the entire frequency range of 1-600 MHz as shown on the manufacturers catalogs and literature.

3.6 SPARE PARTS

- A. As part of this contract the SCS installer shall provide the following spare parts.
 - 1. Ten (10) modular SCS jacks.
 - 2. Five (5) faceplates
 - 3. Two (2) faceplates with support post.
 - 4. Ten (10) fiber optic connector of each type used in the project.
- B. As part of this contract the SCS installer shall provide the following tools:
 - 1. Two (2) modular SCS jacks termination tools when modular SCS jacks required a manufacturer specific tool.
 - 2. One (1) punch down tool with a 110 blade and one 66 blade.
 - 3. One electric (1) cable finder.

3.7 COMISSIONING

A. SCS Installer shall follow all warranty and service requirements indicated in specification section 270010.

3.8 ENGINEER'S FINAL ACCEPTANCE TEST

- A. SCS Installer shall follow all requirements for final acceptance indicated in specification section 270010.
- B. The Engineer's final acceptance test will not include testing of structured cabling components, but could include verification of cleanness of fiber optic connectors.

3.9 TRAINING AND INSTRUCTION

- A. Training shall only be done after all testing, identification process and commissioning have been completed and passed as indicated in this specification. Any training done prior to final acceptance will not be accounted for the formal training requested and the SCS installer shall re-do all training after the final acceptance test is passed, at no additional cost to the Owner.
- B. SCS Installer shall follow all training requirements indicated in specification section 270010
- C. The training for the SCS shall include the following topics:
 - 1. Detail explanation of the identification system.
 - 2. A walkthrough of all spaces and locations where terminations have been done in the project.

3.10 AS BUILT DOCUMENTS AND PROJECT CLOSE OUT

- A. The SCS shall follow all requirements for as-build and close out documents indicated in specification section 270010
- B. The following are additional requirements supplementing the information provided in specification section 270010:
 - 1. Provide the Warranty certificate issued by the manufacturer of the SCS infrastructure.
 - 2. The installer's RCDD shall affix his/her stamp to the as-built drawings, indicating that he/she has reviewed and approved the drawings as being complete, accurate, and representative of the system as actually installed.
 - 3. As built drawings inside each telecom room. The SCS installer shall plot all as-built drawings and locate them inside each of the telecom rooms in the project. Each telecom room shall have the as-built drawings of the areas being served from that room. Each drawing shall be placed inside a clear vinyl document protector the size of the actual design drawing and affixed to a wall/plywood in the telecom room. The document protector shall be re-usable and shall allow the owner to replace the drawings as changes are done to the SCS infrastructure in the future. Without this information, substantial use of the system will not be provided to the installer.
 - 4. The SCS installer shall provide Excel software spreadsheet that defines the telecommunications outlet number, location, number of voice, data and special jacks. This database shall also provide the outlet patch panel connection to the riser/inter-floor cable, equipment, and telephone company demarcation circuit pairs as part of the as-built documentation.
 - 5. Electronic copies of all test results (copper and fiber). Electronic copies shall include raw data files and PDF files with results. PDF files shall be organized the following way:
 - a. All copper cables for cables terminating in one telecom room in a single PDF files with the name equal to the label used in the shop drawings for the telecom room where the cables are terminated.
 - b. All attenuation and OTDR test for all strands of a single cable shall be in one PDF file with the name corresponding to the Cable ID used in the shop drawings.

END OF SECTION 271000

SECTION 27 1126 COMMUNICATIONS RACK MOUNTED POWER PROTECTION AND POWER STRIPS

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. The scope of work shall include furnishing all labor, materials, and programming of different power devices used with Telecommunications and Security equipment such as Uninterrupted Power supplies (UPS), limited energy power transfers and Power Distribution Units (PDUs), also referenced as power strips.
- B. The UPS units covered in this specification section are typically all rack mounted units but could include free standing units. The free standing UPS units covered in this specification are all units that are limited energy that do not require a hard wired connection to the power source. Centralized power supplies are covered in the Electrical Specification section (Div. 26).
- C. Programming and installation of all UPS, power transfers and PDUs.

1.2 RELATED DOCUMENTS

- A. General Terms and Conditions of the Contract Documents
 - 1. Division 26 Electrical
- B. Supplemental: Refer to the specification sections identified below for additional requirements, which are supplemented by this section.
 - SECTION TITLE
 - 27 00 10 Technology General Provisions
 - 27 05 28 Raceways for Technology
 - 27 10 00 Structured Cabling System
 - 27 05 26 Grounding & Bonding for Telecommunications Systems

1.3 INSTALER QUALIFICATIONS

- A. The selected for this project must be a direct manufacturer authorized representative of the product they propose to provide. All technicians assigned to install and configure this system shall be factory trained and certified for the proper installation of this equipment. This company must be of established reputation and experience, regularly engaged in the supply and support of such systems for a period of at least five consecutive years under the current company name.
- B. Other required installer qualifications are:
 - 1. Any rack mounted UPS units with hard wired connection, shall be connected by a License Electrician.

1.4 MATERIALS ALTERNATES AND SUBSTITUTIONS

A. General: See details for alternates and substitution in specification section 270010

B. Substitutions are acceptable for these system as long as they provide the functionality described on this specification.

1.5 SHOP DRAWINGS AND SUBMITTALS

- A. The Installer shall follow all requirements for shop drawings indicated in specification section 270010.
- B. Within 30 business days of receiving contract approval and notice to proceed, the following items shall be submitted to the A&E for review and approval, as part of the product/installer approval process.
 - 1. Product numbers, specifications, and data sheets for all equipment.
 - 2. Data sheets and samples of all labeling materials and equipment to be used in the project.
 - 3. UPS run time calculations.

PART 2 - PRODUCTS

2.1 POWER DISTRIBUTION UNITS (PDUs)

- A. All equipment cabinets or racks in the project shall be provided with at least one PDU. PDUs selection shall be as indicated in design drawings.
- B. The following specifications are required for all types of PDUs:
 - 1. PDU MONITORING: Outlet level monitoring
 - 2. PDU SWITCHING: Required
 - 3. PDU SWITCHING TYPE: Unit level switching
 - 4. MONITORING PARAMETERS: All units shall have monitoring through an IP Ethernet line, unless specifically indicated in the description of each PDU. The monitoring shall include the following parameters:
 - a. Current and voltage for each phase available in the unit
 - b. Peak Voltage, peak current and power factor for each phase available in the unit
 - 5. MONITORING SPECIFICATIONS:
 - a. Unit shall have an LCD display to show all monitoring settings with scrolling capabilities.
 - b. All PDUs and power transfer shall be the same brand and they should be monitored with the same DCIM software.
 - c. The unit shall be provided with no less than two ports for environmental sensors such as temperature, humidity, etc. Two temperature sensors shall be provided with each unit, to be located one in the front of the rack and one in the back of the rack.
 - d. The unit shall be capable of using threshold remote alarms through e-mail, SNMP traps or XML.
 - e. DCIM software shall be optional. No need for external software, all features shall be available through web browsing if external software monitoring is available
 - 6. COLOR CODING for PDUs. Units shall be color coded. Half the PDUs on each rack shall be one color and the other half another color. There will be two types of colors used: black and blue. The color coding of the PDUs shall include the connector assembly bar and the input cord (close to the plug).
 - 7. All devices shall have a continuous operating temperature range of 50 to 113 DEGF.
- C. PDU Type 1:

- 1. PDU capacity: 208V 30A
- 2. Quantity of power outlets: (16) NEMA 5-20R, (12) C13, (2) C19
- 3. Strip power cord plug: NEMA L14-30P
- 4. Breaker: built in thermal breaker with guard protection. Capacity to match PDU capacity.
- 5. Monitoring: digital display included with readings of amperage and voltage
- 6. Surge suppression: included and built-in.
- 7. Listing: UL listed
- 8. Mounting: horizontally occupying 1 RU of space. The installation of the PDU shall not prevent the removal or installation of equipment in the rack.
- D. Approved manufacturer: Geist Manufacturing, Raritan, Server Technologies, APC, Panduit or approved equal.

2.2 RACK MOUNTED POWER TRANSFERS SYSTEMS (RACK ATS)

- A. Rack ATS shall be provided in location and quantities as indicated in the design drawings.
- B. Rack ATS shall supply redundant AC power to connected equipment. Two AC lines power the unit and if the primary AC power fails, the unit will automatically switch to the alternative power source.
- C. The following specifications are required for all types of rack ATS:
 - 1. MONITORING: Unit level monitoring
 - 2. MONITORING PARAMETERS: All units shall have monitoring through an IP Ethernet line, unless specifically indicated in the description of each rack ATS. The monitoring shall include the following parameters:
 - a. Current and voltage for each phase available in the unit
 - b. Peak Voltage, peak current and power factor for each phase available in the unit
 - 3. MONITORING SPECIFICATIONS:
 - a. Unit shall have an LCD display to show all monitoring settings with scrolling capabilities.
 - b. All PDUs and ATS shall be the same brand and they should be monitored with the same DCIM software.
 - c. The unit shall be capable of using threshold remote alarms through e-mail, SNMP traps or XML.
 - d. DCIM software shall be optional. No need for external software, all features shall be available through web browsing if external software monitoring is available
 - 4. All devices shall have a continuous operating temperature range of 50 to 113 DEGF.
- D. Rack ATS Type 1:
 - 1. ATS capacity: 125V 30A
 - 2. Quantity of power outlets: No less than 16
 - 3. Power outlet configuration: NEMA 5-20R
 - 4. Strip power cord plugs: Two (2) NEMA L5-30P
 - 5. Monitoring: digital display included with readings of amperage and voltage
 - 6. Surge suppression: included and built-in.
 - 7. Transfer time: Less than 10 mS.
 - 8. Listing: UL listed
 - 9. Mounting: horizontally mounted, occupying not more than 2 RU. The installation of the PDU shall not prevent the removal or installation of equipment in the rack.
- E. Approved manufacturer: nVent, Eaton, Raritan (Legrand), APC or approved equal.

2.3 UNINTERUPTED POWER SUPPLY (UPS)

- A. All equipment cabinets or racks in the project shall be provided with one uninterrupted power supply (UPS). UPS selection per rack shall be as indicated in design drawings. The following descriptions apply to each type of UPS:
- B. UPS units labeled in drawings as "208V UPS" shall have the following specifications:
 - 1. Output power capacity: 4000 W/5000 VA
 - 2. Output voltage: 120V and 208V, using a transformer
 - 3. Efficiency at full load: 95%
 - 4. Output voltage distortion: Less than 5% at full load
 - 5. Output Frequency: (sync to mains) 57 63 Hz for 60 Hz nominal
 - 6. Topology: Line Interactive
 - 7. Waveform Type: Sine wave
 - 8. Output Connections: (12) NEMA 5-20R, (2) NEMA L6-20R and (1) L6-30
 - 9. Nominal Input Voltage 208V
 - 10. Input Frequency 50/60 Hz +/- 5 Hz (auto sensing)
 - 11. Input Connections NEMA L6-30
 - 12. Battery Type Maintenance-free sealed Lead-Acid battery with suspended electrolyte, leak-proof.
 - 13. Run time: 9 minutes at full load
 - 14. Communications: RJ-45 10 Base-T Ethernet for web/ SNMP/ Telnet management included.
 - 15. Surge energy rating 1020 Joules
 - 16. Filtering Full time multi-pole noise filtering : 0.3% IEEE surge let-through : zero clamping response time : meets UL 1449
 - 17. Rack Height: no bigger than 7U, including transformer
 - 18. Regulatory Approvals CSA, FCC Part 15 Class A, UL 1778.
- C. UPS units labeled in drawings as "120V Medium UPS" shall have the following specifications:
 - 1. Output power capacity: 2700 W/2880 VA
 - 2. Output voltage: 120V
 - 3. Output voltage distortion: Less than 5% at full load
 - 4. Output Frequency: (sync to mains) 57 63 Hz for 60 Hz nominal
 - 5. Topology: Line Interactive
 - 6. Waveform Type: Sine wave
 - 7. Output Connections: (6) NEMA 5-15R, (2) NEMA 5-20R
 - 8. Nominal Input Voltage 120V
 - 9. Input Frequency 50/60 Hz +/- 3 Hz (auto sensing)
 - 10. Input Connections NEMA L5-30
 - 11. Battery Type Maintenance-free sealed Lead-Acid battery with suspended electrolyte, leak-proof.
 - 12. Run time: 3.5 minutes at full load
 - 13. Communications: RJ-45 10 Base-T Ethernet for web/ SNMP/ Telnet management included.
 - 14. Surge energy rating 459 Joules
 - 15. Rack Height: no bigger than 2U
 - 16. Regulatory Approvals CSA, FCC Part 15 Class A, UL 1778.
- D. For Equipment cabinet and small AV equipment credenza racks and UPS units labeled as "120V Small UPS" shall have the following specifications:
 - 1. Output power capacity: 500 W/750 VA
 - 2. Output voltage: 120V
 - 3. Output voltage distortion: Less than 5% at full load
 - 4. Output Frequency: (sync to mains) 57 63 Hz for 60 Hz nominal
 - 5. Topology: Line Interactive

- 6. Waveform Type: Sine wave
- 7. Output Connections: (6) NEMA 5-15R
- 8. Nominal Input Voltage 120V
- 9. Input Frequency 50/60 Hz +/- 3 Hz (auto sensing)
- 10. Input Connections NEMA 5-15P0
- 11. Battery Type Maintenance-free sealed Lead-Acid battery with suspended electrolyte, leak-proof.
- 12. Run time: 5.5 minutes at full load
- 13. Communications: RJ-45 10 Base-T Ethernet for web/ SNMP/ Telnet management included
- 14. Surge energy rating 459 Joules
- 15. Rack Height: no bigger than 2U
- 16. Depth: Unit shall be no deeper than 18"
- 17. Regulatory Approvals CSA, FCC Part 15 Class A, UL 1778.
- E. Approved manufacturers: APC, Liebert, Tripplite or approved equal. All UPS types shall be provided from the same manufacturer

2.4 IDENTIFICATION AND LABELING TAGS

A. The Installer shall follow labeling materials indicated in specification section 270010.

PART 3 - EXECUTION

3.1 INSTALLATION PRACTICES

- A. General: The Installer shall follow all installation practices indicated in specification section 270010.
- B. PDU MOUNTING. Vertical PDUs should be installed with separately ordered mounting brackets using the manufacturers' installation instructions
- C. PDU ACCESS: Vertical PDUs shall be installed in a way that do not prevent the sliding of equipment out of the rack rails.
- D. EXCESS OF POWWER CORD. All excess power cords for the devices included in this specification section shall be neatly coiled up and handled with Velcro straps.
- E. UPS MOUNTING. Any rack mounted UPS equal or larger than 5KVA shall be installed with sliding rack rails.

3.2 IDENTIFICATION AND TAGGING

- A. The Installer shall follow labeling materials indicated in specification section 270010.
- B. ALL PDUs and UPS shall be labeled with the IP address used to monitor the unit.

3.3 REQUEST OF IP ADRESSES

A. The Installer shall comply with all requirements indicated in specification section 270010 for requesting IP address for the devices included in this specification section.

3.4 SYSTEM WARRANTY AND SERVICE

A. General: The Installer shall follow all warranty and service requirements indicated in specification section 270010.

3.5 ENGINEER'S FINAL ACCEPTANCE TEST

A. General: The Installer shall follow all test requirements indicated in specification section 270010.

3.6 TRAINING AND INSTRUCTION

- A. General: The Installer shall follow all training requirements indicated in specification section 270010.
- B. The Installer shall provide a two (2) hour training on the use of the DCIM software to monitor the devices part of the scope of this specification.

3.7 AS-BUILT DOCUMENTS AND CLOSE OUT INFORMATION.

A. General: The Installer shall follow all as built and close out information requirements indicated in specification section 270010.

END OF SECTION 271126

SECTION 27 4100 AUDIO/VISUAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. General: The General Requirements, Conditions of the Contract, these Specifications, Drawings, Addenda and Contract Modifications (the Contract Documents), and definitions of legal entity (such as Contract, Installer, Engineer, Owner, etc...) shall apply to the work of this specification section.
- B. Supplemental: Refer to the specification sections identified below for additional requirements, which are supplemented by this section.
 - 1. 270010 Technology General Provisions
 - 2. 270528 Raceways for Technology
 - 3. 271000 Structured Cabling System
 - 4. 270526 Grounding and Bonding for Communication Systems

1.2 SCOPE OF WORK (SOW)

- A. General: Refer to the requirements of the related documents identified in Part 1.1 of this specification, for scope of work requirements, which are supplemented by this section. This shall constitute the basis for the "Scope of Work" for this specification.
- B. System: The goal of the project is to provide a finished, complete audiovisual system with the functionality, capacity, and operability, as described in the Contract Drawings and specifications herein. The finished, complete system shall serve as a vehicle for the transport of associated system signals from designated origination points to equipment interfaces and/or identified distribution points per the Contract Documents. The scope of work for the AVS installer shall include, but not limited to the following tasks:
 - 1. Preparation of shop drawings, submittals, training and as-built information for the system.
 - 2. Procurement, installation and warranty of all AVS hardware including projectors, flat panel displays, mounts for displays, signal transceivers, players, switchers, servers, etc.
 - 3. Procurement, installation and warranty of all AVS cabling and wiring, including support system, and fire stopping for all low voltage cabling part of the AVS.
 - 4. Programming labor of the AVS, including initial software set up, software registration, and initial data input, unless otherwise noted in this specification section.
 - 5. Attend project plan meetings with the Owner and the Consulting Engineer (A&E) to fine tune data interchange details, network configuration and other user requirements:
 - 6. Provide training and close out information as indicated in this specification.
- C. It shall be understood by the AVS installers that this is an integrated system where multiple pieces of equipment from different manufacturers are required to be connected/interfaced together to make the AVS operational. To allow for competitive bidding multiple manufacturers are listed in the specifications for many devices and software, but it is the sole responsibility of the AVS installers to verify that their particular equipment and software selection integrate and work seamlessly with other equipment and software from the pool of approved manufacturers. These specifications represent a design guideline and design intent but they are not intended to verify that all possible equipment and software listed in this specification work and integrate seamlessly with any equipment and software form the pool of acceptable manufacturers. Approval of submittals for the AVS by the A&E of the project does not relieve the responsibility for the AVS

Project No. 121505 Audio/Visual Systems Section 27 4100 - 1 installers to deliver a working system. Any equipment changes required because of incompatibility between different devices of a particular system, even after the equipment has been approved by the A&E, shall be provided at no additional cost to the owner.

- D. The following is a list of rooms where Audio Visual system shall be provided (including but not limited to refer to AV drawings):
 - 1. Conference Training Room (8 Person) (RM 1313)
 - 2. Multipurpose Room (6 Person) (RM 2618, RM 2536, RM 2647, RM I4203, RM 4233,)
 - 3. IT Training Rm (8 Person) (RM 3205)
 - 4. Conference (8 Person) (RM2221, RM 8264, RM 8117, RM 8238)
 - 5. Conference (6 Person) (RM 8207)
 - 6. Surgery Training Lab (RM2221)
 - 7. Conference Room (12-person) (RM 1233)
 - 8. Meeting Room (12-person) (RM 1507)(RM 2218)
 - 9. Multipurpose RM (12-person) (RM 4151, RM 4143, RM 5221, RM 6218, RM 7221,)
 - 10. Telemedicine Room (10-person) (RM5225)
 - 11. Conference Room (26-person) (RM 3207)
 - 12. Conference Room (39-person) (RM 3209)
 - 13. Conference Room (16-person) (RM 7261)
 - 14. Board Room (16-person) (RM 8266)
 - 15. Multi Purpose (RM1264)
 - 16. Huddle Rooms
 - (RM 1150, RM 1202, RM 2130, RM 2131, RM 2638, RM 5204, RM 6204, RM 7204, RM 8128), (RM 2241) (RM 2723) (RM 1104), Consult (4 people) (RM 4227, RM 4228)
 - 17. Distance Learning Class Room Computer Training Room (17 people) (RM 5227)
 - 18. Command Center (12-Person) (RM1232)
- E. Consumables: The Audio Visual System (AVS) Installer shall provide as part of the scope the following consumable devices:
 - 1. One (1) replacement lamp per each projector in the project.
 - 2. One (1) wind screen for each microphone in the project.

1.3 INSTALLER QUALIFICATIONS

- A. General: The qualifications and requirements herein apply to the specific technology identified by this specification section. Refer to the specification sections identified in Part 1.1 "Related Documents", of this specification, for additional requirements, which are supplemented by this section.
- B. Installer Qualifications: The Installer directly responsible for the work described in this specification section is also referenced as the AVS Installer. The Installer shall be a licensed and registered contractor who is, and who has been, regularly engaged in providing the installation of audiovisual systems of similar size and complexity for at least the immediate past five (5)-years.
- C. Project manager requirements: The project manager for each company participating in the installation of the AVS shall be a Certified Technology Specialist (CTS) by Avixa. Proof of current certification shall be provided with the submittal
- D. Programmer-Installer: The AVS Installer must have a factory-trained programmer/installer, for the provided Project products, in full-time employment, as part of their staff. The AVS installer needs to provide certificates of completion of training for the staff that will be taking part in the execution of this project

- E. Qualification Documentation: The Installer shall provide the following documentation with their bid package, as evidence that the requirements for the Installer qualifications have been satisfied:
 - 1. A list of not less than five (5) references for jobs of similar size and complexity including:
 - a. Project Names
 - b. Locations
 - c. Contact Names
 - d. Contact Telephone Numbers
 - 2. Location (specific street address) of the office from which this installation and warranty work will be performed. It is preferred that the Installer has established and maintains a permanent office within 150 miles of the project site.
 - 3. Copies of Manufacturer certification certificates. It is required that the Installer possess the following certifications, at a minimum:
 - a. Crestron systems certified dealer, installer and programmer.
 - b. AMX certified dealer, installer and programmer.
 - c. Extron certified dealer, installer and programmer
 - 4. Copies of Licensure certificates.
 - 5. Copies of Insurance and Bonding certificates.

1.4 MATERIALS ALTERNATES AND SUBSTITUTIONS

- A. General: See details for alternates and substitution in specification section 270010.
- B. Specific equipment: When the design drawings indicate a brand and a model number for a piece of equipment as part of the audio visual system, the AVS Installer needs to provide the same device as indicated. Substitutions for this type of equipment are not acceptable.
- C. Non-specific equipment: When the design drawings do not indicate a brand and a model number for a piece of equipment as part of the audio visual system, the AVS installer is free to pick equipment that meets the minimum specifications indicated in this section. The AVS installer needs to submit the selected choice as part of the submittal process

1.5 SHOP DRAWINGS AND SUBMITTALS

- A. The AVS installer shall follow all requirements for shop drawings indicated in specification section 270010.
- B. Project Start Submittals: A maximum of 60 days after the AVS installer receives a notice to proceed with the project, but no sooner than a year before substantial completion, the following information shall be submitted.
 - 1. Cut sheets with all specifications of every device, cables and connectors to be used in the project.
 - 2. One-line diagrams with all devices included in the systems. Each system in a different sheet.
 - 3. User interface and faceplate color submittal. The AVS installer shall prepare a separate submittal with the shape and color of all user interface plates to be approved by the Architect of the project or the Owner.
 - 4. Rack elevations of all AV equipment for all rooms in the project.
 - 5. Conduit rough-in requirements of all wall and ceiling mounted devices for all equipment part of the AVS system.
 - 6. An EASE® software model for each of the rooms part of this project to fine tune location of speakers, delays and filter required for these rooms.
 - 7. Any installation and rigging details for loudspeaker systems or other heavy equipment part of the AV system.

- C. Construction Submittals: During the construction process the AVS installer shall submit various documents for approval prior to continuing with the installation process. Here is some of the information the AVS installer needs to submit:
 - 1. Before starting the programming process the AVS Installer shall provide the following information:
 - a. A schematic presentation of the layout of all the user interfaces in the project. The AVS Installer needs to get approval of this submittal before starting any programming. These layouts shall include all graphics with all button sizes, shapes, colors and wording to be used in all user interfaces. All keypads shall include working for engraving in the buttons.
 - b. Completely fill out network configuration template provided by TLC Engineering upon request, to explain all network devices to be used in a project and to get IP addresses from the network administrator.
 - c. A layout/presentation of any digital audio programming and user interfaces that are part of the project.
 - d. Detailed layout of the DSP filters to be used in each DSP processor.
 - 2. Any design changes whether originated by the Owner, Designer or by the AVS Installer as a VE suggestion need to follow the same submittal process described in the previous paragraph for all equipment involved on the change.

1.6 PROJECT SPECIFIC SOURCE CODE OWNERSHIP

- A. Definition of project specific source code: Project specific source code includes all source code created to generate an executable file to be intended to run in any equipment used in the installation of the AVS. Examples of project specific source code include source code used to generate executable files for control processors, DSP processors and touch panels. Project specific source code does not include source code used to create programming tools and compilers or source code used to generate operating systems or application programs running in PC based workstations.
- B. Ownership: Any project specific source code used in this project shall remain the exclusive property of the Owner. By accepting the contract to perform the work included in this project, the AVS installer or designer and any other companies working creating project specific code during this project relinquish the right of ownership of this source code, and waive any licensing fees or royalties for the use of source code by the Owner or any company authorized by the owner to perform changes in the source code after the project is substantially completed for an undefined period of time.

PART 2 - PRODUCTS

2.1 SYSTEM FUNCTIONS

- A. System Signals for All Systems
 - 1. General: The completed system shall be capable of receiving, processing, routing and distributing the associated signals, noted herein, from and to the respective devices identified under Part 2 of this specification and the Contract Documents.
 - 2. The system shall provide an audio signal response of ±6dB un-equalized (±3dB equalized) from 65Hz to 18KHz, throughout.
 - 3. Digital video signals through the system shall be capable of delivering 1920X1080 resolutions at 24 fps from end to end.

- 4. Control signals through the system shall be maintained to the minimum level established by the control equipment manufacturer for the control protocol utilized. This level shall be correct at all connection points in the system.
- B. Computer Based User Interface
 - 1. General: The computer based user interface (CBUI) is another way for the Owner to control the AVS. This interface is in the form of a computer software program with the following requirements:
 - a. Needs to be an executable file capable of running in any Windows based PC.
 - b. One file per controllable room is required.
 - c. Needs to have the same user functions available inside the room in touch screens and keypads.
 - d. The "look" and layout of the interface shall be the same as the one in the room.
 - e. Programs shall be password protected and have SSL.
 - 2. Delivery: The AVS Installer shall provide two (2) USB drives with all the programs in executable and source code format inside. Each file shall be properly labeled with the room description and the room number.
- C. Owner Provided Input Sources and Destination Devices
 - General: Design drawings could indicate AV equipment, part of the AVS, to be provided by owner (as OFE or owner furnished) or third parties. Such equipment is explicitly indicated as such in design drawings to distinguish it from all other equipment to be provided by the AVS installer. When such equipment is indicated in the drawings the AVS Installer shall interface with it. Refer to the design drawings for audio, video and control lines required for owner provided equipment.
 - 2. Scope of work: It is in the scope of work of the AVS Installer to run, terminate and connect the audio, video and control lines to owner provided devices as shown in the design drawings. When control lines are indicated in the design drawings, the AVS installer shall program all control features described in each system functions per controllable room, including all features related to owner provided equipment or third party equipment.

2.2 FUNCTIONAL REQUIREMENTS

- A. General: The AVS Installer/integrator shall provide a complete and operable system with the minimum functional requirements noted herein.
- B. Controllable devices: The AVS described shall have a microprocessor based controller as indicated in the design drawings. This controller shall be capable of managing all input sources, output devices and other devices part of the AVS. Refer to design drawings to determine what and how many signal types will be used for each controllable device.
- C. User Interfaces: The Owner shall be able to operate and receive system status information from the AV system through the following user interfaces:
 - 1. A wall mounted keypad.
 - 2. A wall mounted touch screen
 - 3. A desk mounted touch screen
 - 4. A podium mounted keypad
 - 5. A podium mounted touch screen
 - 6. Computer based user interface.
 - 7. Remote Asset management software
- D. User control: The Owner shall be able to use the above mentioned user interfaces to operate the AV system. All user interfaces shall be able to perform all tasks unless otherwise noted in the

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

TLC Engineering Solutions

Project No. 121505 Audio/Visual Systems Section 27 4100 - 5 design drawings or this specification. The Owner shall be able to perform the following tasks and get the following status indication from the user interfaces:

- 1. System On-Off with status indication
- 2. Individual display device on/off control and video mute.
- 3. Select and route any audio and video source to any of the available audio and video output devices. Each output device shall provide indication in the user interface of the current source selected for that output.
- 4. Playback control of any recorded media capable of operating in the available input sources. Status indication for playback control include end of tape indication, selected function and invalid action. The playback control shall at least provide the following functions:
 - a. Play
 - b. Stop
 - c. Rewind
 - d. Forward
 - e. Fast Rewind
 - f. Fast Forward
 - g. Pause
 - h. Frame by frame controlled playback
 - i. Digital media Menu navigation controls.
- 5. TV channels selection. TV channel selection shall be provided by the following methods:
 - a. Manual entering channel number
 - b. Pick from a list of ten (10) favorite channels. Favorite channels shall be labeled by the name of the network and the channel number. The owner will provide list of favorite channels for this room.
 - c. Channel up and down, by moving up or down in the list of available channels.
- 6. Selected audio output device(s) volume control. Volume level should always be set to an acceptable user level during power up. Status indication of volume level shall be provided for each controllable output device.
- 7. Selected audio output device(s) volume mute. Mute status indication shall be provided at user interfaces.
- 8. Audio settings control. Manual equalization control per band and selection from five (5) equalization presets.
- 9. Individual control and status indication of all features for all controllable devices
- 10. Videoconference controls shall include camera control (far end and local camera), include dialing keypad, list of five (5) preset remote locations, re-dial, hag-up, recording of preset locations, source switching (far end and local content) and local microphone mute.
- 11. Voice conference control shall include dialing keypad, hang up and off hook buttons and indicators, five (5) number memory buttons, microphone mute and user recording of memory buttons.
- 12. Lighting control: User shall be able to recall all light scenes programmed in the dimming panel as well as manual controls of all the zones.
- 13. Individual light zone control: User shall be able to use faders for each individual light zone in the room and to save those light pre-sets in the system.
- 14. Shade controls: All on, all off, and 50% From either touchscreen
- E. Special Features: The AVS shall allow the owner to perform certain automated task by means of using the user interfaces. Those task will be available only on the user interfaces mentioned within this paragraph:
 - 1. Automatic source detection. When a video source is detected in any of the inputs, one of the projectors shall be turned on automatically. When there is no video signal detected in any of the inputs for more than 10 minutes and the projector on/off button has not been pressed, the system shall be set to off. If the projector on/off button has been pressed at any time the projector shall be turned off but the audio portion of the system shall be kept on until the system is manually turned off by the user.

- 2. Automatic preset recall. When the owner select to turn on one display devices the control system shall send a command to the lighting control panel to select the appropriate scene more suitable for the presentation mode selected. Shade control shall be part of this light setting. The AVS installer shall coordinate with the electrical installer of the project all the light commands for the light scenes
- 3. Display automation. Motorized Screen shall follow the operation status of the projector, regardless if the manual switch to the screen has been used to operate the screen. When the projector is on the screen shall be down and when the projector is off the screen shall be pulled up
- F. DSP Features: The AVS shall program the DSP audio processor to provide at least the following features, additional to the functionality described above:
 - 1. All inputs and outputs shall be labeled at the physical input/output and by text blocks within the software.
 - 2. All inputs and outputs shall be monitored by RMS metering. Metering shall also be provided throughout the audio chain where appropriate.
 - 3. If audio or video conferencing are not part of the system, microphones shall be input to a standard mic input. Each microphone channel shall have an adjustable HPF (High Pass Filter), compressor/limiter and a 3-band parametric equalizer in its path.
 - 4. If audio or video conferencing are part of the system, microphones shall be input to an Acoustic Echo Cancellation (AEC) input. Noise reduction shall be enabled for reduction of room background noise. Prior to being fed into an Automatic Mixer (AM) with direct outputs, each microphone channel shall also have an adjustable HPF (High Pass Filter), compressor/limiter and a 3-band parametric equalizer in its path.
 - 5. Program audio: Prior to being fed into a matrix mixer, each program channel shall also have an adjustable HPF (High Pass Filter), compressor/limiter and a 3-band parametric equalizer in its path.
 - 6. For all audio outputs there shall be 5-band parametric equalization and 12dB of gain control (+6dB to -6dB).
 - 7. All inputs/outputs shall be connected to a matrix mixer, which will allow for flexibility in routing, gain adjustment and presets.
 - 8. Audio test signal generators (tone, pink noise, white noise) shall be input to the matrix mixer as well.
 - 9. VTC (CODEC) out shall be comprised of a stereo signal mix of all program audio sources with a mix of all microphone inputs.
 - 10. The signal to a capture system, if specified, shall be comprised of a stereo compressed signal mix of all program audio sources combined with a mix of all microphone inputs.
 - 11. The AVS Installer shall create a user monitoring and control interface utilizing Biamp daVinci software. DaVinci software and interface shall be demonstrated to the owner, developed and presented to the owner and after approval be provided, loaded and tested on an owner furnished computer.
 - 12. Audio mix: When program audio is used in the system, sound reinforcement speakers shall play a mixed (left and right) audio from program material at 50% of the level of the program material sent to the program speakers. Volume control adjustments including volume mute shall affect equally the program speakers and the sound reinforcement speakers when program audio is used in the system.
 - 13. The assisted listening output shall be a mono signal compressed a mix of all microphones in the system plus a mix of all program audio, left and right summed
 - 14. Audio output to wall plates shall be a mix of any program audio being played and all microphones in the system mixed, unless microphones are muted by user selection.
 - 15. Videoconference out, shall be a compressed stereo signal mix of all program audio sources with a mix of all microphone inputs at 50% level to each channel (left and right)
 - 16. The signal to the recording system shall be a stereo compressed signal mix of all program audio sources with a mix of all microphone inputs at 50% level to each channel (left and right).
17. Mix-minus for sound reinforcement speakers, tied to the microphones in the conference table.

2.3 WIRE, CABLE, CONNECTORS, AND ACCESSORIES

- A. General: The AVS Installer shall provide the system components and materials necessary to properly install, support, and terminate all audiovisual cabling, in accordance with the related documents identified in Part 1.1 of this specification. Where the Project Electrical Installer has provided a raceway designated for use by this system, the AVS Installer shall coordinate and install all required cables into the provided raceway. The AVS Installer shall also provide and attach all required cable connectors.
- B. Cable: The AVS Installer shall provide all cabling associated with, and required to, provide a complete, operable system in accordance with the Contract Documents. All cable provided by the AVS Installer shall be of a manufacture and quality consistent with the design intent, and shall be reviewed by the Engineer prior to installation.
- C. Cabling in air handling spaces. The AVS Installer is responsible for determining the rating of the cables to be used for the AVS, as per current version of the National Electrical Code. If, at the bidding point the AVS Installer is not certain about the type of cables to be used in the project, the AVS Installer shall assume that all cables need to be plenum rated cables.
- D. Cabling below grade: When cable part of the AVS have to be run in conduits below slab and grade level, the AVS Installer shall use only cables with water-blocking jackets.
- E. Cable signals: The following is a list of signal types and the cables to be used for those signals:
 - Line level audio signal cable: Provide one (1) twisted pair cable for mono signals and two (2) twisted pair cables for stereo signals. Twisted pair cables to be 22 AWG stranded (7X30) tinned copper conductors with overall foil shield (100% coverage), with 22 AWG stranded tinned copper drain wire.
 - 2. Microphone level audio signal cable: Provide one (1) twisted pair cable, 20 AWG stranded (7X28) tinned copper conductors, overall foil shield (100% coverage) with a 20 AWG stranded tinned copper drain wire.
 - 3. Control cable (i.e. RS-232, RS-485 Signal): Provide one (1) cable with 1 or 2 twisted pair 22 AWG stranded bare copper conductors with overall aluminum/polyester foil (100% coverage) and a 24 AWG tinned copper drain wire. Pair count depends on manufacturer's specifications.
 - 4. Digital video, audio and control over twisted pair. Provide one, two or more cables UTP or STP as required by transceiver equipment manufacturer to ensure the digital signal is transported properly up to 328 ft, at maximum resolution indicated in part 2.01 of this specification. If equipment manufacturer supports the use of standard UTP Category (5e, 6 or 6A) for this application, the AVS installers shall provide cables in compliance with specification section 271000 and all cables part of the AVS shall be included in the same warranty as all cables provided under specification section 271000. If equipment manufacturer requires the use of proprietary cables, only these cables shall be used in the project. The color jacket for these cables shall be different from voice/data cables. AVS installer to coordinate color jackets with structured cabling installer.
 - 5. UTP Category cables. Provide UTP category cables for all Ethernet connection part of the AVS as indicated in design drawings, including horizontal cables, patch cords and station cables. All cables part of the AVS shall have all specifications and shall be included in the same warranty as all cables provided under specification section 27100. The color jacket for these cables shall be different from voice/data cables. AVS installer to coordinate color jackets with structured cabling installer.

- 6. Speaker Cable: Provide two (2) unshielded bare high conductivity ETP copper 16 AWG stranded conductors, with overall jacket.
- 7. IR control signal cable. Provide one (1) pair, unshielded twisted pair cable with 22 AWG solid copper conductors.
- 8. Contact closure signal cable. Provide one (1) or more unshielded twisted pair cable with 22 AWG solid conductors. Quantity of pairs as required by the application.
- 9. HDMI Cables. All HDMI cables longer than 10 meters (32.8 ft.) must include an adaptive cable equalizer capable of providing not less than +40 dB of cable compensation @ 825 MHz. Such device must be capable of operating automatically without the need for human intervention and must include an external AC to DC power converter that can accept 100-240VAC @ 50/60 Hz. Furthermore, such device must also include I2C correction circuitry to mitigate the effects of long cable runs on the DDC clock and DDC data signals. HDMI cables shall have the following requirements:
 - a. Support HDMI v2.1 with resolutions up to 8K60 and 4K120 with 12-bit color depth
 - b. Support HDMI v2.1 Category 2 data rates (3.4 Gbit/sec.) lengths up to 7.5 meters
 - c. Support HDMI v2.1 data rates up to 2.25 Gbit/sec. lengths up to 40 meters
 - d. Support PC data rates up to 1.65 Gbit/sec. lengths up to 60 meters
 - e. Supports PC resolutions up to 1600x1200 / 60 Hz and 1920x1200 / 60 Hz
 - f. Made of AWG-22 gauge wires
 - g. Triple shield for noise immunity
 - Cable jacket shall have dual UL Ratings: UL13 (CL2) and UL758 (AWM20276) for non-plenum spaces. In plenum environments cables shall have a CL2P rating or CMP rating.
 - i. RoHS compliant.
 - j. Gold plated connectors
- F. Connectors and plates: The AVS installer shall provide connector and plates to terminate all wiring part of the AVS, regardless if shown or not in the design drawings. As a general guideline the AVS Installer shall follow these recommendations:
 - 1. When custom panels or plates are required in the project, the AVS Installer shall submit detail drawings of all plates for approval by the Design Engineer.
 - 2. Whether shown in the design drawings or not all cables coming out of an outlet box into an equipment shall have a disconnect means at the outlet box with a face plate. Faceplates with grommets are not acceptable as pass-through connections to equipment.
 - 3. All termination of UTP Category (5e, 6 or 6A) cables shall be done in accordance to specification section 271000.

2.4 DEDICATED COMPUTERS FOR AV SYSTEMS

- A. General: The AVS Installer shall provide dedicated workstations for the AV systems as indicated in the design drawings. The specifications of those workstations are:
 - 1. Intel processor (latest model) with no less than 15
 - 2. Latest offering of Microsoft Operating system for professional environments.
 - 3. Minimum of 16 GB of SDRAM
 - 4. Minimum of 500 GB hard drive
 - 5. 512 MB video board
 - 6. Line level audio output.
 - 7. Keyboard and mouse: All workstation for AV systems shall include a wireless keyboard and a mouse. When indicated in the design documents the workstations shall also include a wireless keyboard and a mouse. Wireless keyboards and mouse shall work with standard commercial batteries (AA or AAA) and shall operate at a frequency of 2.4 GHz and present a working range of at least 20 ft.
 - 8. Rack mounted option or a shelf to mount the workstation. Workstation and shelf shall be no bigger than 2 RU.

B. Acceptable manufacturers for the computer system are: Dell, Sony or HP.

2.5 **PROJECTOR TYPE 1 (Refer to Drawings for Quantities and Locations)**

- A. General: The projector referenced in this specification section and in the design drawings as type 1 shall have the following specifications:
 - 1. Projector native image format: 16:9.
 - 2. Light source technology: Laser,
 - 3. Projector technology: DMD, LCD,
 - 4. Brightness: minimum 6000 ANSI Lumens
 - 5. Native resolution: 1920 X 1200
 - 6. Contrast ratio: minimum 900:1
 - 7. Estimated lamp life: minimum 1500 Hours.
 - 8. Lens: Manual zoom and focus
 - 9. Lens throw distance: as indicated in the drawings
 - 10. Usable resolutions: The unit shall be capable of displaying all resolutions, from 480i to 1080P in all HDMI inputs
 - 11. Video input ports: (2) HDMI HDCP compliant, (1) RGBHV, (1) composite video, (1) component video.
 - 12. Audio input ports: (2) unbalanced stereo inputs
 - Audio output ports: One (1) unbalanced stereo variable output, or a digital audio port and a third party audio converter from digital audio to analog stereo audio in RCA connectors.
 - 14. Control ports: RS-232 in a DB9 connector.
 - 15. Warranty: 3 years, commercial grade unit. Consumer grade units with extended warranties not acceptable.
- B. Accessories: This projector shall be supplied with a corresponding lens to achieve the throw distance indicated in the design drawings. Projector mounts shall be provided with all projector. Design selection for the projector mount is Chief Manufacturing Company recommended mount for the projector specified.
- C. Accepted manufacturers:
 - 1. Christie Digital,
 - 2. Panasonic,
 - 3. Sharp,
 - 4. Hitachi,
 - 5. NEC,
 - 6. Mitsubishi,
 - 7. Barco,
 - 8. Epson,
 - 9. Optoma.

2.6 FLAT PANEL DISPLAY TYPE 1 (Refer to Drawings for Quantities and Locations)

- A. General: The flat panel display referenced in this specification section and in the design drawings as type 1 shall have the following specifications:
 - 1. Flat panel display format: 16:9.
 - 2. Flat panel technology: LED,
 - 3. LCD backlight technology: Direct lit LED,
 - 4. Screen size diagonal: As indicated in design drawings ± 1 inch.
 - 5. Bezel: Bezel around screen shall be no bigger than 0.75"
 - 6. Brightness (cd/m2): 500
 - 7. Native resolution: 3840 X 2160

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

Project No. 121505 Audio/Visual Systems Section 27 4100 - 10

- 8. Contrast ratio: 8000:1
- 9. Refresh rate: 120 Hz.
- 10. ATSC tuner included: Yes
- 11. Speakers provided: Yes
- 12. Video input ports: (2) HDMI, (1) RGBHV, (2) Component video, (1) composite video (1) RF.
- 13. Audio input ports: (2) unbalanced stereo inputs
- 14. Audio output ports: One (1) unbalanced stereo output, or a digital audio port and a third party converter from digital audio to analog stereo audio in RCA connectors.
- 15. Control ports: RS-232 in a DB9 connector.
- 16. Warranty: 3 years, commercial grade unit. Consumer grade units with extended warranties not acceptable
- B. Accepted manufacturers:
 - 1. Mitsubishi,
 - 2. LG Electronics,
 - 3. JVC,
 - 4. Panasonic,
 - 5. NEC,
 - 6. Samsung,
 - 7. Sharp,
 - 8. Sony.

2.7 FLAT PANEL DISPLAY MOUNT:

- A. All flat panel displays, regardless of the type, shall be provided with a flat panel display mount.
- B. Articulating wall mounts (AWM): all articulating wall mounts shall have the following specifications:
 - 1. VESA pattern: Universal
 - 2. Display orientation: landscape
 - 3. Maximum extension: The articulating wall mount shall allow a maximum extension form the the wall off: 25 inches
 - 4. Post installation lateral shift: required
 - 5. The mount shall have accessories to mount cameras, speakers (sound bar or side to side). These accessories shall be used when the design drawings indicate those devices to be mounted next to the display.
 - 6. Weight and size capacity: The AVS installer shall select the specific model for the weight and size limits of the flat panel display selected.
- C. Videowall mounts (VWM): all videowall mounts shall have the following specifications:
 - 1. VESA pattern: Universal
 - 2. Display orientation: portrait
 - 3. Mount shall not have any supports on the horizontal midline of the display, because it will conflict with the outlet for the mount.
 - 4. The mount shall have a pop out scissor system that extends forward the display for servicing no less than 12" from the wall.
 - 5. Post installation lateral/vertical display adjustment is required.
 - 6. Weight and size capacity: The AVS installer shall select the specific model for the weight and size limits of the flat panel display selected.
- D. All flat panel display mounts shall be UL listed.
- E. For this project all displays shall be provided with Articulating wall mounts unless otherwise noted. See design drawings for the specific mount for each display.

F. Approved manufacturers: Legrand (Chief Manufacturing), Peerless AV, Premier Mounts.

2.8 ELECTRIC SCREENS

- A. General: The Electric screen referenced in this specification section and in the design drawings shall have the following specifications:
 - 1. Screen format: 16:9
 - 2. Screen dimensions: As shown in the design drawings ± 3 inches
 - 3. Screen projection type: Front projection,
 - 4. Screen case mounting: in-ceiling,
 - 5. Tensioned screen: Yes
 - 6. Screen gain: 1
 - 7. Viewing angle: 45°
 - 8. Screen fabric: seamless, flame retardant, mildew resistant vinyl.
 - 9. Motor: oil free, quick reversal, with adjustable limit switches.
- B. Accepted manufacturers:
 - 1. Da-Lite,
 - 2. Draper,
 - 3. Screen Innovations

2.9 FIXED SCREENS

- A. General: The fixed down screen referenced in this specification section and in the design drawings shall have the following specifications:
 - 1. Screen format: 16:9
 - 2. Screen dimensions: As shown in the design drawings ± 1 inchs
 - 3. Screen projection type: Front projection,
 - 4. Screen frame type: [describe]
 - 5. Screen gain: 1
 - 6. Viewing angle: 45°
 - 7. Screen fabric: seamless, flame retardant, mildew resistant vinyl.
- B. Accepted manufacturers:
 - 1. Da-Lite,
 - 2. Draper,
 - 3. Screen Innovations

2.10 NETWORKING EQUIPMENT

A. General: All networking equipment required for the AVS shall be provided by the owner unless otherwise note in the design documents.

2.11 CABLE BOX (CABLE RECEIVER)

- A. General: Cable boxes are also referenced as cable receivers
- B. ATSC tuners to be provided shall have HDMI output and simultaneous composite video output, as well as line level audio, RS-232 control and IR control. ATSC tuner shall be Contemporary research 232-ATSC with rack mounted kit or approved equal.

2.12 IDENTIFICATION AND LABELING TAGS

A. The AVS installer shall follow labeling materials indicated in specification section 270010.

PART 3 - EXECUTION

3.1 INSTALLATION PRACTICES

- A. General: The AVS installer shall follow all installation practices indicated in specification section 270010.
- B. Workmanship: The AVS Installer shall adhere to, at a minimum, the following installation practices:
 - 1. Securely mount equipment plumb and square in place. Where equipment is installed in cabinets, provide mounting bolts in all equipment rack fastening holes. All rack mount equipment shall be secured with Rackmount Solutions HTX[™] security screws (STAR-TYPE or similar) provided with nylon washers between bolt heads and equipment.
 - 2. Where equipment (such as video players, monitors, DA's etc... and other system devices) is packaged by the manufacturer without rack mount ears or braces, as part of a regular manufacture process, the Installer shall provide all required, accessory ears, brackets, and shelves, which are necessary to properly mount the equipment within the designated cabinets and rack locations.
 - 3. Provide appropriate ventilation panels, vents, and/or fans to assure sufficient ventilation for adequate cooling of all equipment.
 - 4. Confirm the polarity and phasing of system components before installation. Connect to maintain uniform polarity and phasing.
 - 5. Insulate all non-insulated, stranded conductors before making termination when connecting to equipment terminals.
 - 6. "Wire", "wing" and "twist" NUT type connections are not permissible for any type of signal connection.
 - 7. All wiring is to be free from grounds loops, shorts, opens, and reversals.
 - 8. Neatly tie all cabling within equipment cabinets, housings, and terminal cabinets with nylon cable ties at not more than 12" intervals for cables different from 4-pair CAT cables. Use Velcro straps to tying all 4-pair CAT cables. Install in accordance with the latest EIA installation standards. Engineer approved wiring trough may be used in lieu of tie-wraps. Cable routing shall not braid or cross with other wires in parallel more than once.
 - 9. Secure all cables in equipment cabinets and terminal cabinets to provide strain relief at all raceway exits in accordance with NFPA 70 including all supplements. All plugs and receptacles are to be the grounding type.
 - 10. Connect all equipment power to surge/noise suppression outlet strips or associated power conditioning devices.
 - 11. Where system cables are extended through an exposed umbilical connection, the Installer shall harness all associated cable within a common, manufactured, flexible, sheath (ex. Snakeskin[™]).
 - 12. All racks and cabinets shall be bonded to a grounding system as required by NEC and per specification 270526
- C. Raceways. All raceways for audio/visual devices shall have the following specifications:
 - 1. Refer to specification section 270528 for all raceways specification.
 - 2. All cables for speaker level signals, regardless of their level shall be run in separate raceways from other low voltage cables.
 - 3. All cables for microphone level signals, regardless of their level shall be run in separate raceways from other low voltage cables.

- 4. Separation of Raceways: Raceways for CATV system can be used for AVS distribution cables when required. Cable tray supports can be used as supports for hangers for AVS distribution cables.
- 5. Raceways for AV outlets: Outlets for AV cables shall be composed of electrical boxes (sized for the amount of connectors) and a conduit(s) to the nearest accessible ceiling space. All AV outlet boxes shall be at least 2.5" deep.
- 6. All indoor rated cables can be supported with j-hooks or cable hangers above accessible ceiling spaces. J-hooks shall be spaced no longer than 4. Ft.
- D. Labeling System. The labeling system for all cables shall be a system that allows for unique identifiers for each cable. Each cable has to have an indicator from where it is coming from and an indicator to where it is going to.
- E. Engraving: All push buttons interfaces and connection faceplates part of the AVS shall be engraved with descriptive wording of the use of the button/plate. The AVS Installer shall submit and receive approval for the proposed wording in each button/plate before doing the engraving. Failure to follow this step might cause the AVS installer to replace the buttons in interfaces and/or plates where the Owner is not satisfied with the wording of the label at no additional cost to the Owner. The color of the wording in the engraving shall have high contrast with the background color of the button.
- F. Installation of Screens: Whether shown in the drawings or not the AVS installer shall install all projection screens following the following installation practices:
 - 1. All electric screens shall be provided with a low voltage controller to be mounted inside the screen housing.
 - 2. All electric screens shall be provided with a control wall plate mounted at 48" A.F.F.
 - 3. All in-ceiling screens shall be leveled with the ceiling grid.
 - 4. All in-ceiling screens housing shall be plenum rated when installed in plenum spaces.
 - 5. All in-ceiling screens installed in hard ceilings shall include an access panel no smaller than 16"X16" to access the electrical junction box of the screen. Access panel shall be a metal panel, with a hinged door and painted the same color as the finished ceiling.
- G. Projector Installation: The Installer shall adhere to, at a minimum, the following installation practices for projectors:
 - 1. Projector shall be provided with corresponding mounting brackets depending on the projector selected.
 - 2. All anchors and supports whether pre-fabricated or customs, required to mount the projector where indicated in the design drawings are in the scope of work of the AVS Installer
 - 3. When electronics are provided next to the projector (receivers, controllers, etc.), provide an enclosure to mount all electronics suitable for the space above the ceiling (plenum, nor plenum)
- H. Flat Panel Display Installation: The AVS Installer shall adhere to, at a minimum, the following installation practices for flat panel display devices
 - 1. All anchors and supports whether pre-fabricated or customs, required to mount the displays where indicated in the design drawings are in the scope of work of the AVS installers.
 - 2. All walls where flat panel displays will be installed shall be re-enforced with sheet metal behind the drywall. The extent of the re-enforcing shall be the contour of the flat panel display to be installed.
 - 3. When flat panel displays are installed inside a wall niche, the AVS shall provide a wall mount with adjustable depth that allows the flat panel display to be installed flush with the exterior wall.

- 4. Power and AV outlets to be installed behind flat panel displays shall use an Wiremold Evolution Wall backbox or approved equal
- 5. For flat panel displays mounted on structures, the installer shall provide anchoring as approved by structure manufacturer.
- 6. For flat panel displays suspended from the structure above, the installer of this system shall provide all custom brackets and pipes properly secured to the structure to mount the displays
- I. Speaker Installation: The Installer shall adhere to, at a minimum, the following installation practices for speakers:
 - 1. All ceiling mounted speaker shall have a support wire tie to the building structure. Ceiling speakers shall not be supported from the ceiling grid.
 - 2. All ceiling mounted speakers shall be installed with a backbox to prevent sound from dispersing into the plenum space and causing noise issues in adjacent rooms.
 - 3. When ceiling speakers are mounted in fire rated partitions, the speakers shall have UL listed speaker back boxes with a fire rating no less than the rating of the partition.
 - 4. All in-wall speakers shall be installed with pre-construction brackets.
- J. Equipment Rigging: When speaker assemblies or arrays weight more than 100 lbs, the AVS installers shall follow all rigging instructions from the manufacturer and shall be done by an experienced rigger. The AVS installers shall also adhere to the following practices:
 - 1. Only the rigging equipment and method listed by the manufacturer of the equipment are approved for the installation No substitutions are accepted.
 - 2. Only the rigging points available in the speaker assembly are accepted as means of support.
 - 3. All anchors and supports whether pre-fabricated or customs, required to mount the displays where indicated in the design drawings are in the scope of work of the AVS installers.
 - 4. Shop drawings for rigging methods shall be signed and sealed by a licensed structural engineer.
- K. Millwork Openings: When AV equipment like flip tops and plates will be mounted in millwork provided by the owner or third parties, the AVS installers shall provide cut out dimensions for all the AVS equipment listing location in the millwork where the cuttings need to be done. It is the AVS installer's responsibility to install those devices in the millwork, once the openings have been done. All millwork opening shall be done by the AVS installer.
- L. Floor Boxes. Floor boxes used for connection to teaching lecterns, podiums, conference tables, or mixing borads shall have at least the following minimum requirements:
 - 1. Floor boxes shall be large enough to have at least 4 different compartments, one for power one for voice/data cables and two for AV.
 - 2. Each low voltage compartment shall have a separate raceway back to the accessible ceiling space. If speaker wires are run from the lectern, the AV compartment shall have one 1" and one ³/₄" conduit to the nearest accessible ceiling space. If no speaker wires are run from the lectern, at least one 1" conduit from the AV compartment to the accessible ceiling shall be provided. Additional conduits might be required depending on the application.
 - 3. There shall be no daisy-chaining of AV conduits between adjacent floor boxes. Floor boxes shall also allow to recess the connectors from the umbilical cord tied to the lectern.
 - 4. Floor boxes shall have a recessed compartment to hold connectors. Floor boxes that leave AV connectors flushed with the floor are not desirable since they become tripping hazards and could be easy broken with the lectern when moved.
 - 5. AV compartments shall have termination plates and connectors for all cables coming from the accessible ceiling space. Pass-through cables shall not be allowed in floor

boxes. All connectors shall be properly secured to the plates in the floor box. All unused compartments shall have blank plates.

- M. Structured Cabling Infrastructure: The AVS Installer shall adhere to specification section 271000 for all requirements of structured cabling components to be used as part f the AV system. The structured cabling components include but are not limited to:
 - 1. All unshielded twisted pair Category cables and fiber optic cables
 - 2. Termination devices like termination jacks, patch panels and faceplates.
 - 3. All UTP and fiber optics patch cords.
 - 4. All testing procedures for Category and fiber optic cables.

3.2 REQUEST OF IP ADDRESS

A. General: The AVS installer shall follow all requirements indicated in specification section 270010 for the request of IP addresses for devices part of the AVS.

3.3 SOFTWARE PROGRAMMING AND INSTALLER TESTING

- A. The software programming and testing of the AVS system will be a multi-step process. The AVS Installer shall provision in the proposal for the time indicated in each of the steps:
- B. Briefing Step: A maximum of 45 days after the AVS installer receives the NTP for this project, the AVS installer shall request one or more briefing sessions with the Owner and/or design engineer to go over the expectation of each room and clarify any points that might not be clear to the AVS Installer. Some important notes about this step are:
 - 1. The AVS installer shall allocate at least 8 hours of meeting time
 - 2. Travel time will not be counted as part of the meeting time.
 - 3. The quantity of staff required to attend these meetings by the AVS Installer is sole decision of the AVS Installer.
 - 4. Before the start of this step the AVS installer shall have software programming submittals approved as described in part 1 of this specification section.
 - 5. The AVS Installer shall prepare meeting minutes of the key decisions made during these meetings. The approval of these meeting minutes by the Owner and Design Engineer will be accepted as approval notice of this step.
- C. Shop Programming Step: Once the briefing step has been completed and approved, the AVS installer shall allocate off-site programming time to accomplish all the requirements listed in this specification and the clarifications done in the previous step. It is the sole responsibility of the AVS Installer to estimate how many man hours are required for this step. This step does not require approval by the Owner and/or design Engineer.
- D. Field Verification Step: After all AVS equipment has been installed on site and the system has been programmed, the AVS Installer shall request one or more working sessions with the Owner and/or design engineer to verify in the field the functionality of the AVS system. Some important notes about this step are:
 - 1. The AVS Installer shall allocate at least 16 hours of working sessions.
 - 2. Travel time will not be counted as part of the working sessions.
 - 3. The AVS installer shall have different AV media and sources to test all features in the AVS system.
 - 4. The quantity of staff required to attend these meetings by the AVS Installer is sole decision of the AVS Installer.
 - 5. Physical installation of all devices will be checked by the Owner and/or the Design Engineer. Any deviations in the installation of the equipment part of the AVS from this

specifications and previous meetings will be noted by the Design Engineer in a "punch list". This punch list will be send to the AVS installer within the next 5 days of the meeting for immediate corrective action. One punch list will be prepared for each room with AVS.

- 6. The AVS Installer shall prepare meeting minutes of the key decisions made during these meetings that affect the programming sequence. The approval of these meeting minutes by the Owner and Design Engineer will be accepted as approval notice of this step.
- E. Final Adjustment Step: Once the previous step has been approved, the AVS Installer shall allocate time to make any corrections to the AVS system on site based on the conclusions of the previous step. It is the sole responsibility of the AVS Installer to estimate how many man hours are required for this step. This step does not require approval by the Owner and/or design Engineer.
- F. Data Wiring and Fiber Optic Testing: Testing of UTP data wiring, copper patch cords, fiber optic cables and fiber optic patch cords shall be done as indicated in specification section 271000. Testing results shall be submitted as indicated in the same specification section.
- G. Signal Adjustment: The AVS Installer shall ensure that the following adjustments, tests and measurements, at a minimum, have been completed:
 - 1. The system shall be measured and adjusted for optimum signal quality and minimum signal loss, to all audio and video signals, through the system channel, using appropriate test equipment and standardized testing procedures.
 - 2. The system shall be measured and adjusted for optimum signal-to-noise ratio and maximum headroom in the system electronics.
 - 3. The system shall be measured and adjusted to eliminate distortions or degradation of signal resulting from, but not limited to, clipping, hum, noise, and RFI interference.
 - 4. The Installer shall check the quality of each signal, at its source, and compare it against the quality of the signal at various points of its transmission through the system. The Installer shall correct the system for any significant (the lesser of 2dB or the manufacturers throughput requirements) signal distortion or loss.

3.4 SYSTEM WARRANTY AND SERVICE

A. General: The AVS installer shall follow all warranty and service requirements indicated in specification section 270010.

3.5 ENGINEER'S FINAL ACCEPTANCE TEST

- A. General: The AVS installer shall follow all test requirements indicated in specification section 270010
- B. As part of the Engineer's final acceptance all sources, inputs, outputs and interfaces will be tested. Additional notes about the final acceptance test:
 - 1. It is the sole responsibility of the AVS system installer to estimate the time allocated for this step. It is assume that at this point in time all the features of the AVS system are clear to the Owner and the AVS Installer so this step is just to make sure that all the features are working properly as agreed.
 - 2. The AVS installer shall have different AV media and input signal generators to test all input plates and sources in the AVS system.
 - 3. The quantity of staff required to attend these meetings by the AVS Installer is sole decision of the AVS Installer.
 - 4. Failure to complete one or more of the previously issued punch list items or failure to correct any programming changes previously noted will revoke acceptance of the room or system being tested.

5. Final acceptance will be granted on a room by room basis.

3.6 TEST EQUIPMENT REQUIRED.

- A. Test Equipment: The AVS Installer shall supply all testing instruments required for the equipment programming and system tests. The AVS Installer shall use test equipment meeting the minimum specifications, identified herein, to perform system calibrations and adjustments. The AVS Installer shall make available the same test equipment available, for inspection by the Engineer, during Final Acceptance step.
 - 1. Direct reading Audio Impedance Meter.
 - a. Minimum of three frequencies ranging from 250Hz to 4kHz.
 - b. Range 1 ohm to 1M ohm.
 - c. 10% accuracy.
 - d. Direct reading of dBm across 600-ohm load.
 - 2. Digital Multimeter.
 - a. DC to 20kHz bandwidth.
 - b. 300V range.
 - c. 100mV resolution.
 - d. 10M ohms input impedance.
 - e. DC resistance to 0.1 ohms.
 - 3. Dual trace oscilloscope.
 - a. 450MHz minimum bandwidth.
 - b. 1mV/cm sensitivity.
 - c. Dual timebase capability.
 - 4. Sine/Square Wave Generator.
 - a. 5Hz to 5kHz bandwidth.
 - b. Output level of 0dBm with less than 0.5%THD.
 - 5. Sound Pressure Level Meter:
 - a. Applicable Standards: IEC 61672-1, 60651 and 60804 Type 2, ANSI S1.4 Type 2
 - b. Accuracy: ±1.5dB (ref 94dB@1KHz)
 - c. Resolution: 0.1dB
 - d. Digital Display: 4 digital LCD
 - e. Measurement Parameters: SPL, SPL MIN/MAX, SEL, and Leq
 - f. Measurement Range: 30dB to 130dB
 - g. Linearity Range: 100dB
 - h. Measurement Frequency Range: 31.5Hz to 8KHz
 - i. Frequency Weighting: A and C
 - j. Response Impulse: Fast and Slow
 - k. Microphone: 1/2 " Electret condenser microphone
 - I. Sampling time: updated every 0.5s
 - m. Bargraph: 4dB steps, 100dB range, 125ms update
 - 6. Digital Video Signal Test pattern generator with output for the following signal types:
 - a. Composite Video
 - b. Component Video
 - c. RGBHV video
 - d. HDMI video (1080p 24 fps)
 - e. SDI

3.7 TRAINING AND INSTRUCTION

- A. General: The AVS installer shall follow all training requirements indicated in specification section 270010. The AVS Installer shall provide the owner with different types of training as described herein.
- B. System Administration Training. The AVS installer shall provide system administration training at the job site as described below:
 - 1. At least 24 hours of training shall be provided.
 - 2. Travel time will not be counted as part of the training sessions.
 - 3. Training will be broken down to a maximum of 4 sessions in different days. Each session shall be limited to 6 hours.
 - 4. The objective of the system administration training will be to properly operate, trouble shoot, calibration and perform specific field repairs to AVS equipment.
 - 5. Field repair and calibration training will be limited to those repairs notes by the manufacturer of the equipment as field repairs done by non factory trained personnel.
 - 6. Training shall be done at the job site with all the equipment operational after final acceptance.
 - 7. Training will be limited to a maximum of 5 attendees per session.
 - 8. Operation and Maintenance manuals shall be delivered at the beginning of this sessions.
- C. User Training. The AVS installer shall provide system administration training at the Job site as described below:
 - 1. At least 24 hours of training shall be provided.
 - 2. Travel time will not be counted as part of the training sessions.
 - 3. Training will be broken down to a maximum of 6 sessions in different days. Each session shall be a maximum of 4 hours.
 - 4. The objective of the user training will be to properly operate the AVS.
 - 5. Training will be limited to a maximum of 20 attendees per session.
 - 6. User short form guides shall be provided to all attendees of the sessions.
 - 7. Short form guides shall provide the users with quick finding ways to operate the system. If AVS operation is different from one room to the other, one separate short form guide shall be provided for each room.

3.8 AS BUILT DOCUMENTS AND CLOSE OUT INFORMATION

- A. General: The AVS installer shall follow all as built and close out information requirements indicated in specification section 270010.
- B. The following information shall be included in the as built drawings:
 - 1. Drawings indicating final floor plan locations of all AV devices
 - 2. One line diagrams with all devices connected in the system.
 - 3. Mounting details
 - 4. Any signed and sealed structural calculations required for the AVS
- C. Additional close out information to be delivered by the AVS installer:
 - 1. All programming source code done by the AVS for this project for all pieces of equipment in digital format (no printed copies required).
 - 2. List of all IP addresses assigned to each equipment part of the AVS.
 - 3. Compiled executable files as requested for Computer based user interface.
 - 4. All printed test results.

END OF SECTION 274100

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 **T**

TLC Engineering Solutions

Project No. 121505 Audio/Visual Systems Section 27 4100 - 19

SECTION 27 4134 BROADBAND DISTRIBUTION SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. General: Telecommunications Drawings apply to work of this section. The overall and detailed Broadband distribution design shown on the drawings, selected materials, device locations, installation details, mounting details, cabling routing and supporting and all technical specifications if provided on the drawings apply to work of this section.
- C. General: Requirements indicated in the following standard apply to the work to be performed under this specification section:
 - 1. TIA-568-C.4 (July 2011) "Broadband Coaxial Cabling and Components Standard". Including addendum and errata.
- D. Supplemental: Refer to the specification sections identified below for additional requirements, which are supplemented by this section.
 - 1. 270010 Technology General Provisions
 - 2. 270528 Raceways for Technology
 - 3. 270526 Grounding and Bonding for Telecommunications Systems
 - 4. 274135 CATV Headend

1.2 **DEFINITIONS**

- A. Agile Receiver: A broadband receiver that can be tuned to any desired channel.
- B. Broadband: For the purposes of this Section, wide bandwidth equipment or systems that can carry signals occupying in the frequency range of 54 to 1002 MHz. A broadband communication system can simultaneously accommodate television, voice, data, and many other services.
- C. Carrier: A pure-frequency signal that is modulated to carry information. In the process of modulation, it is spread out over a wider band. The carrier frequency is the center frequency on any television channel.
- D. CATV: Community antenna television; a communication system that simultaneously distributes several different channels of broadcast programs and other information to customers via a coaxial cable.
- E. CCTV: Closed-circuit television.
- F. CEA: Consumer Electronics Association.
- G. dBmV: Decibels relative to 1 mV across 75 ohms. Zero dBmV is defined as 1 mV across 75 ohms. dBmV = 20 log 10(V1/V2) where V1 is the measurement of voltage at a point having identical impedance to V2 (0.001 V across 75 ohms).

- H. DOCSIS. Data Over Cable Service Interface Specification. This is an international telecommunications standard that permits the addition of high-speed data transfer to CATV system.
- I. Headend: The control center of the master antenna television system, where incoming signals are amplified, converted, processed, and combined into a common cable along with any locally originated television signals, for transmission to user-interface points. It is also called the "Central Retransmission Facility."
- J. MATV: Master antenna television; a small television antenna distribution system usually restricted to one or two buildings.
- K. RF: Radio frequency.

1.3 DESCRIPTION

- A. Broadband Distribution Systems shall provide distribution of video, television signals to all selected spaces in the buildings. The system design anticipates increasing demands for expanded channel capacity. The system shall include, but not be limited to passive and active infrastructure like distribution amplifiers, directional couplers, taps and splitters as required to achieve a fully functional system.
- B. General: Provide, complete with all accessories, a complete distribution system as describe herein and as indicated on the drawings
- C. Standards: Distribution system components and overall system performance shall meet or exceed the following standards:
 - 1. Federal Communications Commission Technical Specifications Title 47, Part 76 as applied to cable television systems.
 - 2. TIA 568.4 Revision D "Broadband coaxial cabling and components"
 - 3. TIA-606-C, "Administration Standard for Telecommunications Infrastructure" with addendum and errata.
- D. RFI: Special emphasis shall be placed on radio frequency interference (RFI) integrity as licensed radio services outside the cable system share the same frequencies designated for use within.
- E. Distribution of direct broadcast satellite service signals, which includes coordinating with Owner's selected service provider for installation of its dish-type antennas and processing the signals as needed to provide specified services combined into a single-feed point ready for connection into the distribution system. Obtain signal levels, and noise and distortion characteristics from service provider as the point of departure for system layout and final equipment selection.
- F. Intent of design drawings: The intent of the design drawings is to indicate the scope of work of the project and to allow the installer to properly bid the project. The design drawings are based on estimated distances between devices. Once all cable are run, the installer shall measure the exact cable footages between equipment locations and shall adjust the calculations of the system to comply with the performance criteria indicated in this specification section. The installer shall change any taps, equalizers or directional couplers to match the modified calculations by the installer, at no additional cost to the owner.

G. For all CATV head end specification and requirements see section 274135, this section only applies to the distribution part of the CATV system.

1.4 SERVICES SUPPORTED

- A. The system configuration will allow the forward distribution of the following incoming TV signals:
 - 1. Analog channels from Cable provider
 - 2. Digital channels from cable provider
 - 3. High Definition channels from cable provider
 - 4. Digital Satellite TV.
 - 5. High Definition channels from Satellite TV
 - 6. Off Air High Definition TV channels
 - 7. Internally generated programming in a central location
 - 8. Internally generated programming from any room with distribution outlets in the facility.
- B. The system bandpass shall allow for the following channel loading and forward distribution:
 1. One hundred and fifty two (152) channels from 47 MHz to 1000 MHz.
- C. The system shall allow for a return path with a loading of 3 channels from 5 MHz to 42 MHz.

1.5 INSTALLER QUALIFICATIONS

- A. Qualifications: The CATV installer installing this system shall be experienced in the design, installation, proof of performance testing and maintenance of broadband cable television systems comparable or larger in size and complexity to the system required on this project. Such experience shall be indicated in a list of successfully completed systems with the submittal for this system. Contact names and addresses for all references shall be provided.
- B. Equipment: The CATV installer executing this work shall own and maintain at least the following equipment for execution and maintenance of this system;
 - 1. A CATV signal level meter capable of measuring levels between 5 and 1000 megahertz for both digital and analog channels. For example Blonder Tongue BTPPRO-1000.
 - 2. CATV Plant certification meter such as JDSU DSAM Wavetek Series Field Meter Model DSAM 6300
 - 3. A flat noise generator or sweep/marker generator capable of providing a calibrated output between 5 and 1000 megahertz.
 - 4. An oscilloscope with a suitable RF detector for use in sweep testing system response.
 - 5. A return loss bridge and variable termination for on-site cable sweep testing prior to installation.
 - 6. A time domain reflectometer designed for operation into 75-ohm polyethylene dielectric cable for verification of installed cable.
 - 7. Composite test sets, simul-sweep equipment and other test systems capable of providing the required functions shall be considered equivalent to the equipment specified.
 - 8. A stripping/coring tool appropriate for 0.500" hardline cable or larger cables.
- C. Resume: A resume of personal cable television experience shall be submitted for the cable foreman, each splicer, each technician, and the system design engineer.
- D. Provisions: The CATV installer shall own and maintain all necessary equipment and tooling to properly provide the system in accordance with recommendations set forth by the manufacturers of each item of system equipment.

1.6 MATERIALS ALTERNATES AND SUBSTITUTIONS

- A. General: See details for alternates and substitution in specification section 270010.
- B. Substitutions are allowed for this system only for active components, as long as they have exactly the same performance as the basis of design.

1.7 SHOP DRAWINGS AND SUBMITTALS

- A. The CATV installer shall follow all requirements for shop drawings indicated in specification section 270010.
- B. Additional information to be included in the shop drawings
 - 1. Cut sheet of all devices to be provided as part of this systems. When multiple devices are in the same cut sheet, the installer shall highlight the specific part number to be used. Cut sheets of the following devices shall be provided:
 - a. All copper and fiber optic cables
 - b. All passive devices
 - c. All amplifiers to be used
 - d. All connectors
 - e. All outlets indicating colors
 - f. All surge suppressors
 - g. All fiber optics equipment
 - 2. Proof of installer qualifications per paragraph 1.5
 - 3. A list of all testing equipment owned by the installer as requested in this specification. The list shall include all make and model number of all devices and the last time they were calibrated.
 - 4. Drawings indicating all outlets in the project, with cable distances included, types of cables and how they are connected to the backbone system. The drawings shall include all pad and equalization calculations to the input of all amplifiers in the system.

1.8 GENERAL SYSTEM PARAMETERS

- A. Devices and products described below may or may not be required for the overall design. If such devices are required in the course of this project to achieve the design distribution parameter, the installer shall provide such devices as a part of their design solution and said devices shall be included as part of the installers package in the bid. These items would include those listed below as well as splitters, taps, couplers and pads.
- B. The CATV installer shall be familiar with the ANSI/SCTE standards and shall follow those standards during the installation process.
- C. Amplifiers: In most cases, the output from the amplifier shall be adequate for building distribution. However in larger building distribution systems, additional amplifiers will possibly be required. If such is the case, Input pad and equalizers shall be provided to compensate for short spacing and cable slope, respectively. Outputs shall be adjusted to the rated sloped output of the amplifier selection (typically 36 dBmv to 44 dBmv or rated output by equipment manufacturer) at the selected frequency range indicated in this specification section.
- D. Output: All outlets shall provide a minimum output of between +3 dBmv and +10dBmv for the complete frequency range specified in this section.

- E. Minimum acceptable distribution system performance at all outlets shall be as follows:
 - 1. RF Video Carrier Level: Between 3 and 12 dBmV.
 - 2. Relative Video Carrier Level: Within 3 dB to adjacent channel.
 - 3. Carrier Level Stability, Short Term: Level shall not change more than 0.5 dB during a 60minute period.
 - 4. Carrier Level Stability, Long Term: Level shall not change more than 2 dB during a 24hour period.
 - 5. Channel Frequency Response: Across any 6-MHz channel in 54- to 220-MHz frequency range, referenced to video, signal amplitude shall be plus or minus 1 dB, maximum.
 - 6. Carrier-to-Noise Ratio: 45 dB or more.
 - 7. RF Visual Signal-to-Noise Ratio: 43 dB or more.
 - 8. Cross Modulation: Less than minus 50 dB.
 - 9. Carrier-to-Echo Ratio: More than 40 dB.
 - 10. Composite Triple Beat: Less than minus 53 dB.
 - 11. Second Order Beat: Less than minus 60 dB.
 - 12. Terminal Isolation from Television to Television: 25 dB, minimum.
 - 13. Terminal Isolation between Television and FM: 35 dB, minimum.
 - 14. Hum Modulation: 2 percent, maximum.
 - 15. RF FM Carrier Level: 13 to 17 dB below video carrier level.
 - 16. FM Frequency Response: More than the 88- to 108-MHz frequency range, signal amplitude is plus or minus 0.75 dB, maximum.
 - 17. FM Carrier-to-Noise Ratio: More than 24 dB.
- F. RF Leakage: Radio frequency leakage into the system shall be in compliance of all FCC rulings and regulations.
- G. Delay: Combined reverse and forward path chroma delay, as measured at the most distant bridged port, to the headend and or main distribution point in the building and back, shall not exceed 28 nanoseconds.
- H. The complete CATV distribution system shall be certified form compliance with DOCSIS 3.1.
- I. All TV outlets in the project shall be provided with two UTP Category cable terminated in an RJ-45 connector at the faceplate and at a patch panel in the telecommunications room side for IPTV. This cable shall be terminated in the same telecom room as the coaxial drop and shall have the same performance, warranty and installation methods described in specification section 27100 for all other voice/data drops in the project.

PART 2 - PRODUCTS

2.1 DISTRIBUTION AMPLIFIERS (NOT AT HEAD END) FOR LARGER SYSTEMS

- A. This amplifier shall be used only in the distribution system and shall have the following specifications:
 - 1. Forward Frequency Range: 54 to 1000 MHz
 - 2. Reverse Frequency Ranfe: 5 to 42 Mhz
 - 3. Forward gain: 35dB
 - 4. Reverse gain: 20 dB
 - 5. Gain Control Range: Through plug in pads
 - 6. Slope Control Range: Through plug in equalizer
 - 7. Input Return Loss: Greater or equal to -16dB
 - 8. Noise Figure: Greater or equal to 6dB
 - 9. Composite triple beat (CTB): -78 dBc

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

Project No. 121505 Broadband Distribution System Section 27 4134 - 5

- 10. Composite Second order (CS)) -74 dBc
- 11. Required output Level: 37/47 dBmV,
- 12. Hybrid technology: Power doubling
- 13. Input/Output Test Point Level: -20dB
- B. Design Selection: Toner TBLE-1035-42, or approved equal with external power supply and required pads and equalizers.

2.2 PASSIVE DEVICES

- A. All passive devices shall have a minimum bandwidth of 5 to 1000 MHz.
- B. Splitters for drops or backbones designed with RG-6 or RG-11 lines: Splitters shall be Blonder Tongue SXRS-2, 3, 4, 6 & 8 as required by the system configuration.
- C. Directional Couplers fro drops or backbones designed with RG-6 or RG-11 lines: shall be Blonder Tongue SRT series, with dB TAP setting as required by the system configuration.
- D. Splitters for backbones designed with PIII-500 or bigger diameter cable: shall be Toner TLP-SP series as required by the system configuration.
- E. Directional couplers for backbones designed with PIII-500 or bigger diameter cable: Shall be Toner TLP-DC series as required for the system configuration
- F. Multi-taps shall be Toner Total tap with 3 or 6 tap housings as indicated by the system configuration. Tap values and quantity of tap ports as indicated in system configuration
- G. Equalizer. Equalizer shall be mounted in the tap housings and shall be a Toner TXMT plate. Equalizers could be mounted also inside distribution amplifiers. The value to equalize shall be as indicated in system configuration.

2.3 OUTLETS

- A. The television outlet shall provide (1) "F" type barrel connector mounted alone or with other structured wiring connectors on a common face plate. Outlets shall be mounted as indicated on the documents, or as otherwise indicated and directly inline with the proposed television location. Coordinate final location based upon provided drawings and coordination with the Owner. A three wire grounded, 120 VAC power outlet shall be located adjacent to the television outlet and be provided by owner selected Division 26 Installer. Coaxial cable shall be provided by the CATV installer to each outlet location indicated on the drawings. Conduit and boxes shall also be provided according to specifications section 270528. Coordinate location with electrical installer if not already provided at time of installation of this work.
- B. Design selection: F- connector with a single barrel connector to match (faceplate style and color) de design selection of the structured wiring system as described in specification section 271000.

2.4 VIDEO DISTRIBUTION CABLE

A. Structural Return Loss Testing: All cable shall be 100% swept tested. Return loss shall not be less than 23dB at any given frequency between 5MhZ and 1000MhZ.

- B. Construction: Cable shall be constructed of a copper clad steel or solid copper center conductor, gas expanded cellular polyethylene dielectric, multiple aluminum braided shields, and an overall jacket. All cables shall have characteristic impedance of 75 Ohms.
- C. Attenuation: Attenuation characteristics in decibels per 100 feet at 20oC shall not deviate more than 10% from the following values:

FREQUENCY (MHz)	RG-6	RG-11	PIII-500
5	0.57	0.36	0.16
55	1.5	0.95	0.54
211	2.87	1.81	1.09
300	3.43	2.17	1.31
400	4.0	2.53	1.53
450	4.28	2.69	1.63
550	4.76	3.01	1.82
750	5.62	3.58	2.16
870	6.09	3.9	2.35
1000	6.54	4.23	2.53

- D. RG-6 Cable: No 18 AWG solid bare copper conductor. Four layers of shield, two aluminum foilpolyester tape aluminum foil, one 60% aluminum braid and one 40% aluminum braid. NEC article 820 compliant jacket suitable for the environment being installed.
- E. RG-11 Cable: No 14 AWG solid bare copper center conductor. Two layers of shield, one aluminum foil-polyester tape aluminum foil and one 60% aluminum braid. NEC article 820 compliant jacket suitable for the environment being installed.
- F. PIII-500: 0.109" diameter copper clad center conductor. Solid aluminum tube swaged onto a high compression micro-cellular foam dielectric core. NEC article 820 compliant jacket suitable for the environment being installed.
- G. Indoor Cables: The following table indicates the design selection for all CATV cables. Cables shall be selected according to the environment in which they will be installed:

CABLE TYPE	GENERAL (CM)	RISER RATED	PLENUM RATED
RG-6	Belden 5339Q5	Use plenum rated cable	Belden 6339Q8
RG-11	Belden 1617A	Use plenum rated cable	Belden1617AP
PIII-500	Use riser rated cable	Commscope P3 500 JCAR	Commscope P3 500 JCAP

- H. Outdoor Cables: When coaxial cables are to be installed outdoors, or underground in conduit, they need to have a jacket with a water blocking compound.
- I. RG-59 cable shall never be used for the distribution system.
- J. For all fiber optic cables and connector for broadband distribution see specification section 271000. All connector for fiber optic cables shall be APC (Angled polished connectors) type connectors.

K. For all 4-pair category cable runs used for IPTV or video distribution, all requirements and specifications indicated in specification section 271000 shall be followed.

2.5 CONNECTORS AND ADAPTER

- A. Site Cable Connectors: All connector shall be as recommended by the Cable manufacturer for the cable size and jacket of the cable.
- B. Connectors for RG-6 cables. All connectors for RG-6 cable shall be one piece compression connectors with color coded sleeve. Design selection: Belden part number SNS1P6QS or equivalent.
- C. Connectors for RG-11 cables. All connectors for RG-11 cable shall be one piece compression connectors with color coded sleeve. Design selection: Belden part number SNS1P11 or equivalent.
- D. Connectors for PIII-500 cables. All connectors for PIII-500 cable shall use a 5/8" 3 pin type connector. Design selection: Amphenol ACC-500-CHT10 or equivalent.
- E. Adapters. The installer shall provide all adapters to connect all different cables listed above to an F type connector or a to a 5/8" 3 pin connector, as required in the design to make complete connections. Design selection: Amphenol ACC series or equivalent.
- F. Crimping: All connectors shall be installed using the connector manufacturer's recommended cutting, coring and pin crimping tools.

2.6 SURGE SUPPRESSION

- A. All coaxial cables entering or exiting a building (above or below ground) shall be surge protected as required by NEC article 820.
- B. All surge suppression devices shall be grounded with an AWG-12 isolated wire to the closest electrical ground.
- C. All surge suppression devices shall be UL 497 listed, gas tube suppression, power passing and specifically designed for broadband network applications.
- D. Design selection: TII in-line coaxial lighting surge protector part number 212FF757225-31.

2.7 FIBER OPTIC BROADBAND TRANSMITTER

- A. The fiber optic broadband transmitter (FOBT) shall be able to transmit broadband signals over a single mode fiber optic link and shall be able to accommodate a variety of different modulation formats such as AM/VSB, 8VSB, QAM, QPSK, etc. The FOBT shall use a high-power, low noise 1310 nm distributed feedback (DFB) laser diodes to transmit the signals.
- B. The specifications of the FOBT shall be:
 - 1. Channel loading: Same bandwidth as requested in part 1.4.B of this specification section.
 - 2. Operating Wavelength: 1310 nm
 - 3. Required Fiber Bandwidth: 1,000 Min. MHz
 - 4. Input Return Loss: =/>16 dB @ 75 Ohm

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 121505 Broadband Distribution System Section 27 4134 - 8

- 5. Back Reflection: -50 min. dB
- 6. Optical Output Power: as indicated in design documents.
- 7. RF Input Level (110 Ch. Load): + 18 dBmV/Ch
- 8. CNR (-1 dBm Input, 77 Ch. Load + QAM 550-860 MHz @ -6dB Ref. Analog): ≥52 dB
- 9. CTB: ≥ 69 dB
- 10. CSO: ≥ -63 dB
- 11. Side Mode Suppression Ratio (SMSR): 30 dB
- 12. Fiber optic connector type: FC (APC) single mode
- 13. Mounting: rack mounted with built in power supply.
- C. Design selection: Blonder Tongue FIBT series or equivalent.

2.8 FIBER OPTIC BROADBAND RECEIVER

- A. The fiber optic broadband receiver (FOBR) shall be able to receive and forward incoming broadband signal and transmit sub-band signal back to the head end over a pair of single mode fiber optic links and shall be able to accommodate a variety of different modulation formats such as AM/VSB, 8VSB, QAM, QPSK, etc.
- B. The optical specifications of the FOBR shall be:
 - 1. Operating Wavelength: 1310/1550 nm
 - 2. Optical Input Range: -8.0 to +2.0 dBm
 - 3. Return laser power: 4.8 dBm, 3 mW
 - 4. Input Connector: SC/APC single mode
- C. The RF specifications of the FOBR shall be:
 - 1. CNR: >52 dB
 - 2. CSO: > 65 dBc
 - 3. CTB: >68 dBc
 - 4. Forward bandwidth: 54-870 MHz
 - 5. Return RF bandwidth: 5- 42 MHz
 - 6. Connector: type F.
- D. The fiber optics broadband receiver shall always be used in conjunction with a Distribution amplifier (not at head end) to amplify the signal to be sent to the outlets.
- E. Design selection: Blonder Tongue FOCN series with return path and DFB laser, and shall be provided with a power supply inserter.

2.9 FIBER OPTIC SUB-BAND RECEIVER

- A. The fiber optic sub-band receiver (FOSR) shall be able to receive and forward return path broadband signal coming from the FOBR over a single strand fiber optic links.
- B. The optical specifications of the FOSR shall be:
 - 1. Operating Wavelength: 1310 nm
 - 2. Optical Input Range: -9.0 to +4.0 dBm
 - 3. Input Connector: FC/APC single mode
- C. The RF specifications of the FOSR shall be:
 - 1. CNR: >50 dB
 - 2. CSO: -70 dB

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 121505 Broadband Distribution System Section 27 4134 - 9

- 3. CTB: -63 dB
- 4. Forward bandwidth: 5-400 MHz
- 5. Connector: type F.
- D. Design selection: Blonder Tongue SIBR-S4A-210.

2.10 FIBER OPTIC BROADBAND COUPLER

- A. The fiber optic broadband coupler (FOBC) shall be a passive device capable of splitting a broadband signal modulates in a fiber optic signal to multiple outputs.
- B. The specifications of the FOBC are:
 - 1. Number Of Inputs: 1
 - 2. Wavelength: 1310 & 1550 nm
 - 3. Number of Outputs: As indicated in design drawings
 - 4. Connectors: FC/APC.

Number of Outputs	2	3	4	6	8
Insertion Loss (Individual Port):	≤3.6 dB	6.0 dB	7.3 dB	9.7 dB	10.8 dB
Uniformity:	≤0.6 dB	1.0 dB	1.0 dB	1.0 dB	1.9 dB
Directivity:	≥ 50 dB				

C. Design selection: Blonder Tongue FOC-22 series.

2.11 IDENTIFICATION AND LABELING TAGS

A. The CATV installer shall follow labeling materials indicated in specification section 270010.

PART 3 - EXECUTION

3.1 INSTALLATION PRACTICES

- A. The CATV installer shall follow all installation practices indicated in specification section 270010
- B. In Raceway: All cables shall be installed in raceways without kinks, dents, or abrasions. Specified pulling strength of cable shall not be exceeded.
- C. All indoor cables shall have no splices at any points.
- D. Terminal Locations: Cables at terminal locations shall be neatly formed using a bending form to prevent kinks or other discontinuities. Cables showing evidence of abuse or physical damage shall be replaced at the installer's expense.
- E. It is envisioned that television service will migrate into the overall telecommunications scheme for a given facility, therefore television distribution shall be accomplished via the following methods. In general, television distribution points shall be located throughout the facility such

and all wiring shall be run back to the Telecommunication closet where the connection to the Broadband distribution backbone will take place.

- F. All unused outputs of splitters, directional couples or distribution taps shall have a 75 ohm termination installed.
- G. All unused cavities of the Toner Total Tap housing shall be filled with blank plates
- H. All equipment with a grounding lug shall be grounded as recommended by the equipment manufacturer to an acceptable grounding point as described by the NEC.
- I. All amplifiers shall be used at the rated output. The installer shall provide the required equalization and attenuation pads for all amplifiers to operate at the rated output at only 80% of the maximum gain control of the unit.
- J. Cable and equipment identifiers shall be provided and shall follow a standard labeling system like TIA/EIA-606. The identification system chosen by the CATV installer shall be submitted for approval to the A&E.
- K. The installer shall use attenuator or adjustment for fiber optic equipment to ensure proper budget levels are getting to each receiver.

3.2 INSTALLATION OF CONNECTORS

- A. Provisions: All connectors shall be installed in strict accordance with the manufacturers' instructions.
- B. Residue Removal: All dielectric residues shall be removed from surfaces of center conductors to insure proper electrical contact.
- C. Preparation: Semi-rigid cables shall have jacket removed to a length of 2" from the cable end to allow proper seating of connectors without scoring of the aluminum sheath. A tubing cutter shall not be used for this purpose. All flooding compound shall be removed from the connector location with a suitable solvent.
- D. Connections: All connections including terminations and connections on flexible cables shall be wrench tightened to insure RFI integrity. Connectors at manhole or exterior pedestal tap locations and antennas shall be filled with Dow Corning #5 compound prior to wrench tightening.
- E. Tooling: Cables shall be prepared to accept connectors using the manufacturer's recommended tooling.
- F. Crimp Connections: Crimp type connections on flexible cables in manholes shall be made with a Hex crimp tool and encapsulated with flooded heat shrink tubing.
- G. Heat Shrink Boot: All cables containing flooding compound shall be provided with a heat shrink boot at all termination points which covers the housing connector boss, body of the connector and extends not less than 12" along the cable jacket. Heat shrink boot shall be of the filled type.
- H. Splices: Cable splices below grade or in other locations shall be made according to manufacturers' recommendations, tested, and covered with a filled heat shrink boot approximately 30" in length. Boot shall contain a resilient compound which melts as heat is

applied and fills all voids between the shrink tube and cable jacket. Resin casts shall not be acceptable.

I. For termination of all Fiber optics and UTP category cable, follow all requirements indicated in specification section 271000.

3.3 EQUIPMENT MOUNTING

- A. Mounting: All remote terminal equipment (amplifiers, taps, couplers etc.) shall be neatly arranged and securely mounted. When installed above the ceiling all devices need to be in accessible places. All accessories required for wall mounting equipment shall be provided when equipment is to be wall mounted.
- B. Integrity: All equipment housing hardware including amplifiers shall be wrench tightened to insure full RFI integrity.

3.4 SYSTEM ADJUSTMENTS

- A. Installation: System design drawings are based on estimated distances between devices. The installer shall measure the exact cable footages between equipment locations and submit a revised drawing to the engineer for review containing the following;
 - 1. Exact footage of each cable
 - 2. Revised coupler and tap values
 - 3. Revised equalizer and pad values.

3.5 SYSTEM PERFORMANCE

- A. General: Upon completion the system shall be adjusted, tested, and left in perfect operating condition.
- B. Provisions: The system shall not exhibit any audible or visible components of hum, noise, or distortion.
- C. Before the system acceptance test, the installer shall test all outlets in the system and document the result in a spreadsheet or an automated test print out from the test equipment. This report is called TEST RESULT REPORT (TRR). The TRR report shall include the following information:
 - 1. Project name and location
 - 2. Day test was done (if done in different days, the report shall be broken in sections by days the tests were done).
 - 3. Name of the installer that performed the test
 - 4. Serial number of the tester used.
 - 5. For each outlet in the project the report shall include:
 - a. Room number:
 - b. Room name:
 - c. Outlet number (with permanent label matching as-built drawings)
 - d. Lowest channel signal level (in dBmV)
 - e. Mid bandwith channel signal level (in dBmV)
 - f. Highest channel (as identified in part 1 of this specification) signal level (in dBmV)
 - 6. For each amplifier in the system the report shall include:
 - a. Room number:

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 121505 Broadband Distribution System Section 27 4134 - 12

- b. Room name:
- c. Lowest channel signal level (in dBmV, measured @ test port)
- d. Mid bandwith channel signal level (in dBmV, measured @ test port)
- e. Highest channel (as identified in part 1 of this specification) signal level (in dBmV, measured @ test port)
- D. All Fiber optics cables and UTP category cable shall be tested in accordance to specification section 271000.

3.6 SYSTEMS WARRANTY AND SERVICE

A. General: The CATV installer shall follow all warranty and service requirements indicated in specification section 270010.

3.7 ENGINEER'S FINAL ACCEPTANCE TEST

- A. General: The CATV installer shall follow all test requirements indicated in specification section 270010.
- B. General: The Installer shall demonstrate the operation of the system to the Architect & Engineer (A&E) during the final inspection in the following manner:
 - 1. Measure signal levels with a calibrated field strength meter at outlets and or amplifiers selected by the A&E. At a minimum 5% of all outlets will be tested. The readings of the meter shall be between 1.5 dBmV of the value documented in the TRR
 - 2. Observe picture quality at outlets selected by the Engineer using a television receiver.
- C. If at least one measurement fails, the A&E can request to the installer to test more outlets (beyond the 5% indicated previously) until the A&E is satisfied with the results. Any failures shall be corrected by the installer at no additional cost to the owner.

3.8 TEST EQUIPMENT REQUIRED

- A. At a minimum during the acceptance test to the A&E the installer shall have the following equipment:
 - 1. TV Receiver: 17" minimum diagonal screen size color receiver in good working order.
 - 2. Signal Meter: This signal meter needs to be the same tester used during the TRR
- B. Age and Calibration: Test equipment used in demonstrating system performance shall be less than 6 months old or bear the calibration seal of a recognized lab which is dated within 6 months of the date of acceptance test.

3.9 TRAINING AND INSTRUCTION

- A. General: The CATV installer shall follow all training requirements indicated in specification section 270010.
- B. The training shall include the following topics:
 - 1. How to make connectors part of this system with the provided tools.
 - 2. How to balance the system with amplifiers at rated output

- 3. A walk-through of the facility pointing out the location of all active and passive equipment part of this system and showing to the owner the as-built drawings with matching labels for those pieces of equipment.
- 4. A complete training on the use of the test tool provided.

3.10 SPARE PARTS AND TOOLS

- A. As part of this contract the installer of this system shall provide the following materials and tools:
 - 1. Twenty (20) RG-6 connectors, same make and model as the units used in this project.
 - 2. A new and unused crimping tool for the RG-6 connector specified.
 - 3. A new and unused coaxial cable stripping tool
 - 4. Five (5) 75 Ohm terminators (f connector)
 - 5. One (1) 5/8" 75 Ohms terminator.
 - 6. One (1) signal level meter as the one used for the TRR
 - 7. Two (2) surge protectors.

3.11 AS BUILT DOCUMENTS AND CLOSE-OUT INFORMATION

- A. General: The CATV installer shall follow all as built and close out information requirements indicated in specification section 270010.
- B. General: As built drawings shall include the following information:
 - 1. A block diagram of the entire system indicating all cable routing and lengths
 - 2. Revised coupler and tap values for each cable drop
 - 3. All cable types, active components, and passive components.
 - 4. All equalizing and attenuating pads used for each amplifier.
 - 5. All system settings.
 - 6. All brands and part number of all devices shall be indicated in the drawings.
 - 7. Location of each outlet and the unique label identifier of each outlet.
 - 8. High/low signal level measured at each amplifier test port.
- C. Additional information to be provided by the CATV installer, as part of the close out information:
 1. A copy of the TRR signed approved by the A&E.

END OF SECTION 274134

SECTION 27 4135 CATV HEADEND

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. General: Telecommunications Drawings apply to work of this section. The overall and detailed CATV headend design shown on the drawings, selected materials, device locations, installation details, mounting details, cabling routing and supporting and all technical specifications if provided on the drawings apply to work of this section.
- C. Supplemental: Refer to the specification sections identified below for additional requirements, which are supplemented by this section.
 - 1. 270010 Technology General Provisions
 - 2. 270528 Raceways for Technology
 - 3. 270526 Grounding and Bonding for Communication Systems
 - 4. 274134 Broadband Distribution

1.2 DESCRIPTION

- A. The CATV headend shall produce a broadband signal from multiple AV sources to be distributed though the facility by the Broadband Distribution Systems to get to all TV outlets in the building. The system design anticipates increasing demands for expanded channel capacity. The system shall include, but not be limited to all signals receiving infrastructure including antennas and antenna cables as well as all headend equipment as required to achieve a fully functional system.
- B. Standards: Distribution system components and overall system performance shall meet or exceed requirements set forth in Federal Communications Commission Technical Specifications Title 47, Part 76 as applied to cable television systems.
- C. RFI: Special emphasis shall be placed on radio frequency interference (RFI) integrity as licensed radio services outside the cable system share the same frequencies designated for use within.
- D. A telecommunications grounding bus bar shall be installed as per specification section 270526 inside the CATV head end room. If the raceways from the roof into the CATV head end room are not continuous additional grounding shall be provided at the first point of discontinuity of the raceway to ground all incoming cable protections.
- E. For all CATV distribution specifications see section 274134. This specification only relates to CATV headend equipment.

1.3 SERVICES SUPPORTED

- A. The CATV head end configuration shall produce a CATV broadband signal with the following number of channels:
 - 1. (5) Analog channels from Cable provider
 - 2. (100) High Definition channels from cable provider
 - 3. (3) Off Air High Definition TV channels
 - 4. (3) channels Internally generated programming in a central location
- B. The system bandpass shall allow for the following channel loading and forward distribution:
 1. One hundred and fifty two (152) channels from 47 MHz to 1000 MHz.
- C. The system shall allow for a return path with a loading of 3 channels from 5 MHz to 42 MHz.

1.4 INSTALLER QUALIFICATIONS

- A. Qualifications: The CATV installer installing this system shall be experienced in the design, installation, proof of performance testing and maintenance of broadband cable television systems comparable or larger in size and complexity to the system required on this project. Such experience shall be indicated in a list of successfully completed systems with the submittal for this system. Contact names and addresses for all references shall be provided.
- B. Equipment: The CATV installer executing this work shall own and maintain at least the following equipment for execution and maintenance of this system;
 - 1. A CATV signal level meter capable of measuring levels between 5 and 1000 megahertz. For example Blonder Tongue BTPRO-1000
 - 2. A flat noise generator or sweep/marker generator capable of providing a calibrated output between 5 and 1000 megahertz.
 - 3. A signal level meter capable of measuring level between 950 Mhz and 2150 Mhz for satellite signals.
 - 4. An oscilloscope with a suitable RF detector for use in sweep testing system response.
 - 5. A return loss bridge and variable termination for on-site cable sweep testing prior to installation.
 - 6. A time domain reflectometer designed for operation into 75-ohm polyethylene dielectric cable for verification of installed cable.
 - 7. Composite test sets, simul-sweep equipment and other test systems capable of providing the required functions shall be considered equivalent to the equipment specified.
- C. Resume: A resume of personal cable television experience shall be submitted for the cable foreman, each splicer, each technician, and the system design engineer.
- D. Provisions: The CATV installer shall own and maintain all necessary equipment and tooling to properly provide the system in accordance with recommendations set forth by the manufacturers of each item of system equipment.

1.5 MATERIALS ALTERNATES AND SUBSTITUTIONS

- A. General: See details for alternates and substitution in specification section 270010.
- B. Substitutions are allowed for this system as long as all substitutions do not represent and change in architecture and have exactly the same performance as the basis of design.

1.6 SHOP DRAWINGS AND SUBMITTALS

- A. The CATV installer shall follow all requirements for shop drawings indicated in specification section 270010.
- B. Additional information required to be submitted:
 - 1. Proof of installer's qualifications per paragraph 1.4.
 - 2. A list of all testing equipment owned by the installer as requested in this specification. The list shall include all make and model number of all devices and the last time they were calibrated.
 - 3. Drawings indicating all components of the head end, rack elevations, CATV room layouts and channel assignment lists.

1.7 GENERAL SYSTEM PARAMETERS

- A. Devices and products described below may or may not be required for the overall design. If such devices are required in the course of this project to achieve the design distribution parameter, the CATV installer shall provide such devices as a part of their design solution and said devices shall be included as part of the CATV installers package in the bid. These items would include those listed below as well as splitters, taps, couplers and pads.
- B. General: Building distribution shall consist of a system of foam-dielectric, jacketed, non-pressurized cable.
- C. Carrier to Noise: System carrier to noise ratio shall not be less than 48 dB.
- D. Modulation: Hum modulation shall be a minimum of 59dB below visual carrier levels.
- E. Composite Triple-Beat: Composite triple-beat products shall be a minimum of 55dB below forward visual carrier levels.
- F. Aural Carrier: Aural television carriers shall be maintained at a level of 15dB below visual carrier level.

PART 2 - PRODUCTS

2.1 AGILE MODULATOR FOR MODULAR HEAD END

- A. The agile modulator shall be a professional quality, heterodyne audio/video modulator. The unit shall provide audio video modulated RF carrier output on any single VHF or CATV channel, including: broadcast TV (2 13), CATV (14-135).
- B. RF signal specifications:
 - 1. Frequency Range: 54-860 MHz
 - 2. Channels: CATV, VHF, UHF (STD, HRC, IRC)
 - 3. FCC Offset (pre-programmed): 0, +12.5, or 25 kHz
 - 4. Output Level Min: +45 dBmV
 - 5. Output Level Adjust: 15 dB
 - 6. Aural/Visual Carrier Ratio: -10 to -17 dB
 - 7. Visual Carrier Frequency Tolerance: Standard Channels: ±5 kHz. FCC Aeronautical Channels: ±3 max kHz

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

- 8. 4.5 MHz Aural Inter Carrier Frequency: ±1 Hz
- 9. Channel Selectivity: Adjacent Aural and Below: -40 dB. Adjacent Picture and Above: -50 dB
- 10. Spurious Outputs: -60 dBc
- 11. C/N Ratio In Channel: 65 dB
- 12. Broadband Noise: -76 dBc
- 13. Output Impedance: 75 ohm
- 14. Output Return Loss: 12 dB
- C. Video signal specifications:
 - 1. Frequency Response: fv-0.5 MHz to fv+4.2 MHz: ±1.0 dB. P-P Video to RMS Hum Ratio: 65 dB
 - 2. Video Signal-to-Noise Ratio: NTC-7 Weighted: 62 dB
 - 3. Differential Gain: 2.0 %
 - 4. Differential Phase: 1.0 °
 - 5. Over Modulation Indicator: 87.5, ±2.5 %
 - 6. Input Impedance: 75 ohm
 - 7. Input Return Loss: 24 min, dB
- D. Audio signal specifications:
 - 1. Input Level: 140 mV RMS
 - 2. Ext. 4.5 MHz Input Level: 40 ±1 dBmV
 - 3. Frequency Range: 20 Hz to 20 kHz
 - 4. Pre-Emphasis-Mono: 75 µs
 - 5. Frequency Response: ±1.0 dB. IF Pre-Emphases defeated: +0.5 dB
 - 6. Audio Signal-to-Noise: 58 dB
 - 7. Total Harmonic Distortion: 0.6 %
 - 8. Over Modulation Indicator: 25, ±2 kHz
 - 9. Input Impedance: Greater than $10k \Omega$, unbalanced
- E. Connector and control specifications:
 - 1. Video Input connector: "F" Type, Female
 - 2. Audio Input connector: RCA Phono, Female
 - 3. RF Output connector: "F" type, Female
 - 4. Power connector: Header, 3 Pin
 - 5. Frequency Selection: Push-Button Switches
 - 6. Video Level: Control
 - 7. A/V Ratio: Control
 - 8. Audio Level: Control
 - 9. RF Output Level: Control
 - 10. Channel Enter: Push Button
- F. Design selection: Blonder Tongue modular head end AMCM-860.
- G. Accessories: The channelized modulators shall be housed in a rack mounted card cage with capacity for 12 units and power supply. The housing with power supply shall be the Blonder Tongue MIRC-12V. The quantity and location of these devices shall be as indicated in the design drawings.

2.2 DISTRIBUTION AMPLIFIERS (AT HEAD END)

- A. This amplifier shall be used only in the head end system
 - 1. Frequency Range: As stated in paragraph 1.3. B of this section
 - 2. Gain: Minimum 33dB

- 3. Gain Control Range: Greater or equal to 15dB
- 4. Slope Control Range: Greater or equal to 10dB
- 5. Input Return Loss: Greater or equal to 14dB
- 6. Noise Figure: Greater or equal to 7dB
- 7. Output Level: 36/44 dBmV,
- 8. Hybrid technology: Power doubling
- 9. Input/Output Test Point Level: -20dB
- 10. Design Selection: Blonder Tongue RMDA series, or approved equal.

2.3 AGILE MODULATOR (FOR MOBILE CART)

- A. The agile AV modulator shall be a professional quality agile audio/video modulator. Any standard audio/video source shall be able to be used, such as satellite receivers, television cameras, video tape recorders, or television demodulator.
- B. RF signal specifications:
 - 1. Frequency Range: 54-5500 MHz
 - 2. Channels: CATV, VHF, UHF (STD, HRC, IRC)
 - 3. FCC Offset (pre-programmed):
 - 4. 0, +12.5, or 25 kHz
 - 5. Output Level Min: +42 dBmV
 - 6. Output Level Adjust: 10 dB
 - 7. Aural/Visual Carrier Ratio: -15 ±5 dB
 - 8. Visual Carrier Frequency Tolerance
 - 9. Standard Channels: ±10 kHz
 - 10. FCC Aeronautical Channels: ±5 max kHz
 - 11. 4.5 MHz Aural Inter Carrier Frequency: ±150Hz
 - 12. Channel Selectivity:
 - 13. Adjacent Aural and Below: -40 dB
 - 14. Adjacent Picture and Above: -50 dB
 - 15. Spurious Outputs: -60 dBc
 - 16. C/N Ratio In Channel: 67 dB
 - 17. Broadband Noise: -80 dBc
 - 18. Output Impedance: 75 Ohm
 - 19. Output Return Loss: 14 dB
- C. IF signal specifications:
 - 1. Aural Frequency Standard: 41.25 MHz
 - 2. Visual Frequency Standard: 45.75 MHz
 - 3. Composite IF Loop Output
 - 4. Aural Carrier Level: +20 dBmV
 - 5. Visual Carrier Level: +35 dBmV
 - 6. Output/Input Impedance: 75 Ohm
 - 7. Output Return Loss: 16 dB
 - 8. Input Return Loss: 20 dB
- D. Video signal specifications:
 - 1. Input Level: 1.0 V p-p
 - 2. Frequency Response
 - 3. fv-0.5 MHz to fv+4.2 MHz: ±1.0 dB
 - 4. P-P Video to RMS Hum Ratio: 65 dB
 - 5. Video Signal-to-Noise Ratio, Weighted: 64 dB
 - 6. Differential Gain: 2.0 %
 - 7. Differential Phase: 1.0 °

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

TLC Engineering Solutions

- 8. Over Modulation Indicator: 87.5, ±2.5 %
- 9. Input Impedance: 75 Ohm
- 10. Input Return Loss: 18 dB
- E. Audio signal specifications:
 - 1. Input Level: 140 mV RMS
 - 2. Ext. 4.5 MHz Input Level: +35 to +45 dBmV
 - 3. Frequency Range: 20 Hz to 20 kHz
 - 4. Frequency Response: ±1.0 dB
 - 5. Pre-Emphasis-Mono: 75 µs
 - 6. Audio Signal-to-Noise: 60 dB
 - 7. Total Harmonic Distortion: 0.6 %
 - 8. Over Modulation Indicator : 25, ±2 kHz
 - 9. Input Impedance: 600, balanced Ohm
- F. Connector and control specifications:
 - 1. Video Input Standard: "F" type, female
 - 2. Audio Input Standard 600 Ohm
 - 3. Audio Input: Phono jack
 - 4. IF Output: "F" type, female
 - 5. IF Input: "F" type, female
 - 6. RF Output: "F" type, female
 - 7. EAS/ALT IF: "F" type, female
- G. Design selection: Blonder Tongue AM-40-550B.
- H. Accessories: The agile AV modulator shall be provided with the sub-band output module AM-OPT 04.

2.4 AGILE PROCESSOR

- A. The Agile processor shall be a professional quality, agile heterodyne processors equipped with the Emergency Alert System (EAS) feature, which can also be used as an alternate IF input. These units shall convert any channel in the 50 to 806 MHz (7 to 43 MHz with Option 17) frequency range to any channel in the 50 to 550/750 MHz (7 to 550/750 MHz with Option 04) frequency range.
- B. RF signal specifications:
 - 1. Input Frequency Range
 - 2. Standard: 54-88 & 108-806 MHz
 - 3. Option 17 Sub-band Input: 7-49 MHz
 - 4. Input Channels: SUB, VHF, UHF, CATV (STD, HRC)
 - 5. Output Frequency Range: 50-550 MHz
 - 6. Output Channels: SUB, CATV (STD, HRC, IRC)
 - 7. Tuning Increment: 250 kHz
 - 8. FCC Offset: 0, +12.5, or +25 kHz
 - 9. Input Level Range: -18 to +30 dBmV
 - 10. AGC Stiffness: 1.0 dB
 - 11. Output Level Min: +40 dBmV
 - 12. Output Level Adjust: 10 dB
 - 13. Noise Figure
 - 14. VHF: 8 dB
 - 15. UHF: 10 dB
 - 16. Aural/Visual Carrier Ratio: 0 to -10 dB

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 TL

Project No. 121505 CATV Headend Section 27 4135 - 6

TLC Engineering Solutions

- 17. Visual Carrier Frequency Tolerance
- 18. Standard Channels: ±10 kHz
- 19. FCC Aeronautical Channels: ±3 kHz
- 20. Channel Selectivity:
- 21. Adjacent Aural and Below: -65 dB
- 22. Adjacent Picture and Above: -65 dB
- 23. Spurious Outputs: -60 dBc
- 24. Intermod Distortion: -64 dB
- 25. Broadband Noise: -76 dBc
- 26. Image Rejection: 65 dB
- 27. Bandpass Flatness fv to fv+4.5 MHz: ±1.0 dB
- 28. Input/Output Impedance: 75 ohm
- 29. Input Return Loss: 12 dB
- 30. Output Return Loss: 14 dB
- C. IF signal specifications:
 - 1. Aural Frequency: 41.25 MHz
 - 2. Visual Frequency: 45.75 MHz
 - 3. Composite IF Loop Output
 - 4. Aural Carrier Level: +13 dBmV
 - 5. Visual Carrier Level: +28 dBmV
 - 6. Output/Input Impedance: 75 ohm
 - 7. Output Return Loss: 12 dB
 - 8. Input Return Loss: 12 dB
 - 9. EAS/ALT IF Input Level: 28 dBmV @ 45.75 MHz
 - 10. EAS/ALT IF Switch Isolation: >60 dB
- D. Connector and control specifications:
 - 1. RF Input
 - 2. Standard VHF/UHF: "F" Type, Female
 - 3. Option 17: Sub-band Input: "F" Type, Female
 - 4. IF Output: "F" Type, Female
 - 5. IF Input: "F" Type, Female
 - 6. RF Output: "F" Type, Female
 - 7. Serial Data Input & Output Option 20: Serial
 - 8. Input: RJ-12, Female
 - 9. EAS/ALT IF: "F" Type, Female
 - 10. Frequency Selection
 - 11. Input: DIP Switches
 - 12. Output: DIP Switches
 - 13. Frequency Response Adjust: Controls
 - 14. Aural Carrier Level: Control
 - 15. Frequency Fine Tune: Control
 - 16. FCC Offset Selection Option 12: ABOC:
 - 17. DIP Switches
 - 18. RF Output Level: Control
 - 19. Standby Oscillator Threshold Adjust: Control
 - 20. Sub-band Input Channels Option 17:
 - 21. Slide Switch
 - 22. EAS/ALT IF: 3 Position, Terminal Strip
- E. Design selection: Blonder Tongue AP-40-750B
- F. Accessories: The agile processor shall be provided with the sub-band input t module when indicated in the drawings.

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

TLC Engineering Solutions

2.5 COMBINERS

- A. Type: Passive
- B. Frequency Range: 5 to 1000 MhZ
- C. Insertion Loss: 18dB
- D. Return Loss: 16dB
- E. Isolation: 38dB
- F. Number of outputs: as indicated in design drawings.
- G. Design Selection: Blonder Tongue OC-series.

2.6 DIGITAL VIDEO RECORDER/PLAYER

- A. Provide a standalone unit capable of reproducing DVD or CDs with JPEG video program.
- B. Unit shall have RF input capable of tuning VHF/UHF spectrum.
- C. Unit shall have Baseband video and stereo audio output.
- D. Design Selection: JVC MV40US. Unit shall include rack mount kit or equipment shelf.

2.7 SCAN CONVERTER

A. The scan converter shall be an Extron VSC500.

2.8 HIGH DEFINITION PROCESSOR

- A. The high definition processor shall be a two-unit system consisting of a Downconverter unit which acts as the input section and an Upconverter unit which acts as the output section. Both units shall be housed in a single die-cast chassis and shall be available in both horizontal and vertical versions.
- B. The Downconverter unit shall be designed to accept any 8VSB signal from 54-860 MHz. Channel entry shall be made using a 2 digit front panel accessible BCD switch. (I.E. - VHF 2-13, UHF 14-69 & unused spectrum 806-860 MHz). The Downconverter outputs shall be an IF signal which is fed to the Upconverter unit.
- C. The Upconverter unit shall be designed to take the IF signal from the downconverter and process it to any channel from 54-860 MHz. Channel entry shall be made using a 2 digit front panel accessible BCD switch. (I.E. CATV STD, IRC & HRC as well as Broadcast VHF & UHF).
- D. Downconverter RF specifications:
 - Input Frequency Range: (8VSB)
 - a. VHF 2-13: 54-216
 - b. UHF 14-69: 470-806

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

1.

- c. UHF Extended: 806-860
- 2. Operating Input Range: -10 dbmV to +20 dBmV
- 3. Input Level Range:
- 4. (AGC Controlled) -20 dBmV to +25 dBmV
- 5. Adj. Ch. Rejection: (Ref. to +30 dBmV IF output)
- 6. Adj. Aural and Below: >65 dB
- 7. Adj. Visual and Above: >65 dB
- 8. Output Frequency: 44.00 MHz IF
- 9. Output Level: +30dBmV (-20 dBmV to
- 10. +25dBmV Input)
- 11. L.O. Leakage on RF Input Port: -50 dBmV
- 12. Phase Noise: @ 10 KHz Offset -85 dBc/Hz
- E. Downconverter General specifications:
 - 1. Connectors (Rear Panel):
 - a. RF Input: "F" Type, Female
 - b. IF Output : "F" Type, Female
 - 2. Power: 3 Pin Polarized Receptacle
 - 3. Controls (Front Panel):
 - a. Channel Selection: 2 Digit Push Button
 - b. Channel Enter: Push Button
 - 4. Indicators (Front Panel):
 - a. Power ON/Status OK: 2 color LED/Green
 - b. Status (Error): 2 color LED/ Red
- F. Upconverter RF specifications:
 - 1. Output Frequency Range: 54-860 MHz
 - 2. Channels: CATV- STD, IRC, HRC Broadcast; VHF, UHF
 - 3. Output Frequency Tolerance: ±5 KHz
 - 4. Output Level:
 - a. Analog: +45 dBmV (IF Input +35 dBmV)
 - b. Digital: +40 dBmV (IF Input +30dBmV)
 - 5. Output Level Adj. Range: 10 dB
 - 6. Channel Flatness: 1 dB
 - 7. Spurious Output 50-1000 MHz: -60 dB
 - 8. C/N Ratio IN Channel:
 - a. Digital: -60 Db (6 MHz BW +40 dBmV Output)
 - b. Analog: -65 dB (4 MHz BW +45 dBmV Output)
 - 9. Broadband Noise: -76 dBc (4 MHz BW +45 dBmV Output)
 - 10. Phase Noise: @ 10 KHz Offset -88 dBc, @ 20 KHz Offset -98 dBc
 - 11. Output Impedance: 75
 - 12. Output Return Loss: 12 dB
- G. Upconverter General specifications:
 - 1. Connectors (Rear Panel):
 - a. IF Input: "F" Type, Female
 - b. RF Output : "F" Type, Female
 - 2. Controls (Front Panel):
 - a. Channel Selection: 2 Digit Push Button
 - b. Channel Enter: Push Button
 - c. RF Output Level: Control
 - 3. Indicators (Front Panel):
 - a. Power ON/ Status OK: 2 Color LED/Green
 - b. Status/ Error: 2 Color LED/Red

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

TLC Engineering Solutions

- H. Design selection: Blonder Tongue DHDP processor.
- I. The high definition processor shall be provided with the corresponding chassis and power supply.

2.9 QAM TRANSCODER

- A. The QAM transcoder shall be able to accept one input in 8VSB (digital off-air) or QAM (digital cable) format, and delivers one output in QAM format in the 54-864 MHz range.
- B. The specifications of the QAM transcoder shall be:
 - 1. INPUT
 - a. Input Connector: "F" Female
 - b. 8VSB/16VSB Standard: ATSC Digital Television A/53E
 - c. QAM standard: ITU-T J.83 Annex A & B (16, 32, 64, 128, and 256 QAM)
 - d. 8VSB/16VSB Modes
 - e. Tuning Range: UHF (NTSC Ch. 14-69), VHF (NTSC Ch. 2-13)
 - f. Data Rate: 19.392 Mbps
 - g. Bandwidth: 6 MHz
 - h. 8VSB Power Level: -28 to 20 dBmV
 - i. 16VSB Power Level: -25 to 20 dBmV
 - j. QAM Mode
 - k. Tuning Range: CATV (NTSC Ch. 2-135)
 - I. Data Rate: 38.8 Mbps (QAM 256); 26.97 Mbps (QAM 64) Auto Detect
 - m. Bandwidth: 6 MHz
 - n. Power Level: -20 to +20 dBmV
 - o. Impedance: 75 Ω
 - 2. OUTPUT
 - a. Output Connector: "F" Female
 - b. QAM Modulation Modes: 16, 32, 64, 128, & 256
 - c. DVB Symbol Rate: Variable; 1 to 7 MSymbols/sec (Mbaud)
 - d. Frequency Range: 54 to 864 MHz
 - e. QAM Tuning NTSC: Per channel's number from 2 to 135
 - f. RF Level: $+40 \text{ dBmV} \pm 1 (100 \text{ dB}\mu\text{V} \pm 1)$
 - g. RF Level LCD Screen Error: ± 2 dB
 - h. RF Level Adjustment Range: 30 to 40 dBmV
 - i. Frequency Stability: ± 5 kHz over 32 to 122 °F (0 to 50 °C)
 - j. Frequency Tolerance: ± 0.5 kHz @ 77 °F (25 °C)
 - k. Amplitude Flatness: ± 0.25 dB (over 6 MHz channel)
 - I. Phase Noise: -98 dBc (@ 10 kHz)
 - m. Spurious: -60 dBc
 - n. Broadband Noise: -75 dBc (@ +40 dBmV output level, 4 MHz bandwidth)
 - o. Impedance: 75 Ω
 - p. Return Loss: 12 dB
 - q. Spectral Inversion: Auto Recognition
 - r. Carrier Suppression: 55 dB
 - s. SNR: Greater than 40 dB
 - t. MER: Greater than 40 dB
 - u. I/Q Phase Error: Less than 1 degree
 - v. I/Q Amplitude Imbalance: Less than 1%
- C. The QAM transcoder shall be a Blonder Tongue AQT series with corresponding card cage.
2.10 DIGITAL ENCODER

- A. The digital encoder shall be used to encode a high definition video signal to a QAM coding signal for distribution in a broadband system.
- B. The specifications of the digital encoder shall be:
 - 1. Input Connector: HDMI
 - 2. Video Standard: 480i, 720p, 1080i:
 - 3. Transport Rate: Variable, user-selectable from 9.7 to 100 Mbps
 - 4. Video Rate: Variable, user-selectable
 - 5. Video Pre-filter: Variable, user-selectable
 - 6. GOP Size: Variable, user-selectable from 1 to 60
 - 7. Intra DC Precision: Variable, user-selectable from 8- to 11-bit
 - 8. Chroma Formats: 4:2:0 and 4:2:2 (ITU-R BT.601)
 - 9. Colorspace Formats: YCbCr and RGB
 - 10. Packet Format: MPEG-2 188-byte Transport Stream
 - 11. Audio: Compressed Dolby® Digital Pass-Thru
 - 12. Primary connector out: "F" Female
 - 13. RF Test Port connector out: "F" Female (@ 20 dB below Primary output)
 - 14. QAM Modulation Modes: 16, 32, 64, 128, 256, 512, & 1024
 - 15. DVB Symbol Rate: Variable; 1 to 7 MSymbols/sec (MBaud)
 - 16. Frequency Range: 54 to 864 MHz
 - 17. QAM Tuning: NTSC: Per channel's number from 2 to 135
 - 18. RF Level: +60 dBmV ±1 (120 dBµV ±1)
 - 19. RF Level LCD Screen Error: ± 2 dB
 - 20. RF Level Adjustment Range: 50 to 60 dBmV
 - 21. Frequency Stability: ± 5 kHz over 32 to 122 °F (0 to 50 °C)
 - 22. Frequency Tolerance: ± 0.5 kHz @ 77 °F (25 °C)
 - 23. Amplitude Flatness: ± 0.25 dB (over 6 MHz channel)
 - 24. Phase Noise: -98 dBc (@ 10 kHz)
 - 25. Spurious: -60 dBc
 - 26. Broadband Noise: -75 dBc (@ +60 dBmV output level, 4 MHz bandwidth)
 - 27. Impedance: 75Ω
 - 28. Return Loss: 12 dB
 - 29. Spectral Inversion: Auto Recognition
 - 30. Carrier Suppression: 55 dB
 - 31. SNR: Greater than 40 dB
 - 32. MER: Greater than 40 dB
 - 33. I/Q Phase Error: Less than 1 degree
 - 34. I/Q Amplitude Imbalance: Less than 1%
 - 35. Encoding Profile
 - 36. Video: MPEG 2 HD; ISO 13818-2; 1080i, MPEG 2 SD; ISO 13818-2; 480i
 - 37. Audio: Pass through compress audio, Does Closed Captioning not required
- C. The digital encoder shall be a Blonder Tongue HDE-QAM.

2.11 QAM MODULATOR

1

- A. The QAM modulator shall be capable of accepting an ASI signal and modulate it into a QAM signal.
- B. The specifications of the QAM modulator are:
 - QAM Modulator
 - a. QAM Modulation Modes: 16, 32, 64, 128, 256, 512 & 1024 QAM

Project No. 121505 CATV Headend Section 27 4135 - 11

- b. Symbol Rate: Variable, up to 10 Mbaud
- c. Input: ASI (Asynchronous Serial Interface per EN 50083-9)
- d. LVDS Parallel Input Option Available
- e. FEC Encoder: Complies with ITU-T J.83 Standards, Annex A (DVB) & Annex B (DigiCipher® & OpenCable/DOCSIS)
- f. Spectral Inversion: Auto Recognition
- g. Carrier Suppression: 55 dB
- h. MER: 40 dB
- i. I/Q Phase Error: <1 degree
- j. I/Q Amplitude Imbalance: <1 %
- 2. RF Output
 - a. Channel Range: 2 to 135
 - b. Frequency Range: 54-864 MHz
 - c. Frequency Step: 6 MHz (Channel Center)
 - d. Frequency Stability: ±5 kHz
 - e. Output Level: +40 dBmV
 - f. Output Level Control Range: 10 dB
 - g. Amplitude Flatness: ±0.25 dB
 - h. (over 6 MHz CH)
 - i. Output Impedance: 75 Ohm
 - j. Phase Noise @ 10 kHz Offset: -98 dBc/Hz
 - k. Spurious (54-1000 MHz): -60 dBc/Hz
 - I. Broadband Noise: -77 dBc (@ +40 dBmV Output, 4 MHz BW)
- C. The QAM modulator shall be a Blonder Tongue AQM series with corresponding power supply and chassis.

2.12 MESSAGE SERVER

- A. The message server shall be capable of storing audio and video content and play it on an output port based on some conditional events.
- B. The message server shall have the following specifications:
 - 1. Network Connector: RJ-45
 - 2. Network Standard: 10/100/1000 BaseT
 - 3. Content Protocols: FTP & SMB
 - 4. Content Throughput: Up to 80 Mbps
 - 5. Formats: MPEG-1/2 CBR & VBR, DVD, FLASH, JPEG, BMP, GIF, PNG, HTML, MPEG-1 Layer II, AC-3, Linear PCM Audio
 - 6. Storage Capacity: 400 GB
 - 7. Network Management
 - 8. Network Management Interfaces: Web Browser
 - 9. Protocols: SMB, HTTP, NTP, Remote Management & Software Upgrades
 - 10. Software OS: Linux
 - 11. Video Connector: "BNC" Female (shipped with a BNC/F adapter)
 - 12. Audio L/R Connector: Mini XLR (shipped with a 6 ft audio adapter cable XLR to (2) RCA Male connectors)
 - 13. Video output: NTSC Composite Video
 - 14. L/R Analog Audio level: 0.5 Volt Peak-to-Peak
 - 15. Audio Frequency Response: Software Adjustable 20 Hz to 22 kHz +/- 0.5 dB
- C. The message server shall be a Blonder Tongue DVS-400.

2.13 BAND FILTER

- A. Type: Band suppression
- B. Frequency Range: Up to 1GHZ of band pass
- C. Channel suppression: At least 50dB for selected band
- D. Possible suppression bands: The band filer shall have options to filter the following bands channels: T7 to 13, 2 to 6, A-2 to I, 7 to 13, J to W, AA to YY and AAA to RRR.
- E. Insertion loss on band pass channels: Max 2 dB
- F. Adjacent carrier insertion loss (Max): 5 dB
- G. Selected band to suppress: The CATV contractor shall coordinate with the owner and the Cable provider the band to be suppressed with this filter. The band to be suppressed shall have at least 8 consecutive channels to be able to re-insert the internally generated channels.
- H. Design Selection: Microwave Filter Company, Brickwall 3271 series channel filter.

2.14 VHF/UHF PRE AMPLIFIERS

A. The VHF/UHF pre amplifier shall be a Blonder Tongue .CMA series with in line power supplies. The frequency of operations of the VHF/UHF shall be as indicated in the design documents. Each set of two pre-amplifiers shall have its own in-line power supply. The power supply for the VHF/UHF pre amplifiers shall be a Blonder Tongue PS-1536.

2.15 VHF/UHF ANTENNAS

A. The VHF/UHF antennas shall be the Blonder Tongue BTY series as indicated in the design drawings. All antennas shall be provided with a mounting bracket and the custom poles to guarantee proper mounting.

2.16 TELEVISION PREVIEW MONITOR

- A. The Broadband system shall be equipped with a preview monitor located in the equipment rack
- B. The monitor shall be 15" LCD rack mounted with speakers and volume control.
- C. Design selection: Marshall V-R151P with a separate ATSC tuner, contemporary research 232-ATSC with a rack mounted kit.

2.17 TEST PATTERN GENERATOR

- A. Provide a portable test pattern generator capable of test signal programming of both video and audio (analog and digital).
- B. The test patter Generator shall be an Extron VTG 400DVI.

Project No. 121505 CATV Headend Section 27 4135 - 13

2.18 EXTERNAL POWERED LAUNCH AMPLIFIER

- A. Frequency range: Terrestrial passive: 5 to 862 Mhz, Satellite 950 to 2200 Mhz.
- B. Gain: Terrestrial passive: -3.5 dB, Satellite: 19 to 23 dB
- C. Rejection: Terr. Passive to SAT: > 30 dB
- D. Isolation: Trunk to Trunk: > 35 dB
- E. Noise figure: Terrestrial: 8.5 to 7.5 dB, Satellite: 9.5 to 7 dB
- F. LNB supply voltage: 12V, 18V/ 22 Khz selectable
- G. Design selection: Spaun SBK5502NF.

2.19 CASCADABLE DIRECTIONAL COUPLER

- A. Frequency range: Terrestrial passive: 5 to 862 Mhz, Satellite 950 to 2200 Mhz.
- B. Rejection: Terr. Passive to SAT: > 5 dB
- C. Isolation: Trunk to Trunk: > 28 dB
- D. Design selection: Spaun DMK5562F or DMK5582F

2.20 DISH ANTENNA

- A. Size: 0.9 m.
- B. Frequency range: 10.95 12.75 GHz
- C. Reflector f/D ratio: 0.59
- D. Offset Angle: 22.5 DEG
- E. Gain: 40 dB min @ 12.45 GHz
- F. Aperture efficiency: 69.5% min
- G. LNBF mounting: rectangular channel.
- H. LNBF: Double LNBF Dish Pro or DirecTV compatible
- I. Design selection: Blonder Tongue KU0.92 dish with non-penetrating roof mount.

2.21 SURGE SUPRESSORS FOR ANTENNA FEEDS

- A. Protection method: Gas discharge surge protector.
- B. Frequency range: 0 to 2.5GHz.

Project No. 121505 CATV Headend Section 27 4135 - 14

- C. Insertion loss: 0.5 dB from 0 to 2.5GHz.
- D. Impedance: 75 Ohms.
- E. Gas tube breakdown voltage: 50V ± 20%
- F. Gas tube switching: <100 ns
- G. Connectors: F type connector.
- H. Design selection: Altelicon ALF or approved equal by Andrew.

2.22 PASSIVE DEVICES

- A. Splitters: Splitters shall be Blonder Tongue SCVS-2, 3, 4 & 8 as required by the system configuration.
- B. Directional Couplers shall be Blonder Tongue SRT, SRT-2A, SRT-4A as required by the system configuration.
- C. Multiplexers: Shall be a Blonder Tongue DSV series as required by the system configuration.
- D. All passive devices shall be exhibit a high frequency range up 1 GHz minimum.

2.23 VIDEO HEADEND CABLE

- A. Structural Return Loss Testing: All cable shall be 100% swept tested. Return loss shall not be less than 23dB at any given frequency between 5MhZ and 1000MhZ.
- B. Construction: Cable shall be constructed of a copperclad steel or solid copper center conductor, gas expanded cellular polyethylene dielectric, multiple aluminum braided shields, and an overall jacket. All cables shall have Characteristic impedance of 75 Ohms.
- C. Shield: Shield shall be a minimum of two component construction consisting of one layer of tape and one layer of 60% aluminum braided by an aluminum braid. Outer shield coverage shall be 100%.
- D. Attenuation: Attenuation characteristics in decibels per 100 feet at 20oC shall not deviate more than 10% from the following values:

FREQUENCY (MHz)	RG-6	RG-59
5	0.57	0.6
55	1.5	2.1
211	2.87	3.6
300	3.43	3.8
400	4.0	4.6
450	4.28	5.0
550	4.76	5.5
750	5.62	6.5

870	6.09	
1000	6.54	7.6

E. Indoor Cables: The following table indicates the design selection for all CATV cables. Cables shall be selected according to the environment in which they will be installed.

CABLE TYPE	GENERAL (CM)
RG-6	Belden 5339Q5
RG-59	Belden 1505A

2.24 CONNECTORS

- A. Site Cable Connectors: All connector shall be as recommended by the Cable manufacturer for the cable size and jacket of the cable.
- B. All connectors for RG-6 cable shall be one piece compression connectors with color coded sleeve. Design selection: Thomas&Betts, part number SNS1P6QS or equivalent.
- C. All connectors for RG-59 cable shall be one piece compression connectors with color coded sleeve. Design selection: Thomas&Betts, part number SNS1P59U or equivalent.
- D. Crimping: All connectors shall be installed using the connector manufacturer's recommended coring and pin crimping tools.

2.25 EQUIPMENT RACK

- A. Free standing enclosed equipment rack shall be provided to house headend equipment as indicated on the drawings.
- B. All racks shall be according to specification section 17120-271000
- C. Racks shall conform to EIA standard 19" wide equipment mounting with 1.75" center spacing and all accessories as indicated on the drawings.
- D. The racks shall not have doors in the front but it shall have solid doors in the back
- E. The equipment racks shall be provided with vertically mounted power strips with at least 10 or 12 AC outlets. These power strips shall include surge suppressors.
- F. All unused rack spaces in the front of the cabinet shall be covered with perforated panels.
- G. Design Selection Winsted Pro-Series II with casters, side rails and grounding kit.

PART 3 - EXECUTION

3.1 INSTALLATION PRACTICES

A. The CATV installer shall follow all installation practices indicated in specification section 270010.

- B. In Raceway: All cables shall be installed in raceways without kinks, dents, or abrasions. Specified pulling strength of cable shall not be exceeded.
- C. Terminal Locations: Cables at terminal locations shall be neatly formed using a bending form to prevent kinks or other discontinuities. Cables showing evidence of abuse or physical damage shall be replaced at the installer's expense.
- D. All equipment with a grounding lug shall be grounded as recommended by the equipment manufacturer to an acceptable grounding point as described by the NEC.
- E. All amplifiers shall be used at the rated output. The installer shall provide the required equalization and attenuation pads for all amplifiers to operate at the rated output at only 80% of the maximum gain control of the unit.
- F. Cable and equipment identifiers shall be provided and shall follow a standard labeling system like TIA/EIA-606. The identification system chosen by the CATV installer shall be submitted for approval to the A&E.
- G. The installer shall maintain the required UHF/VHF antenna separation (horizontal and vertical) between different antennas mounted in the same mast, to prevent any interference between antennas.

3.2 INSTALLATION OF CONNECTORS

- A. Provisions: All connectors shall be installed in strict accordance with the manufacturers' instructions.
- B. Residue Removal: All dielectric residue shall be removed from surfaces of center conductors to insure proper electrical contact.
- C. Tooling: Cables shall be prepared to accept connectors using the manufacturer's recommended tooling.

3.3 EQUIPMENT MOUNTING

- A. Workmanship: All headend equipment shall be mounted in a neat orderly manner. If no cabinet or rack is indicated, equipment shall be neatly secured to the backboard in the communications room. All operating controls shall be accessible without removal of equipment.
- B. Mounting: All remote terminal equipment (amplifiers, taps, couplers etc.) shall be neatly arranged and securely mounted.
- C. All equipment and cabling shall be grounded to the ground bus bar on the backboard.
- D. When passive devices are to be mounted in a rack or cabinet they shall be screwed down to a perforated rack mounted panel installed in the back of the rack.

3.4 SYSTEM ADJUSTMENTS

A. Input Adjustment: System antenna signal levels shall be padded and/or preamplified to produce the specified input at each amplifier.

- B. Output Adjustment: Headend gain shall be adjusted to produce the specified output levels.
- C. Output level: The output of each modulator, transcoder or processor needs to be adjusted to 2 dB less than the rated output of the unit.
- D. Channel output: All analog channels shall be adjusted have the same signal level (± 1.0 dB) output before going into the first distribution amplifier and after all combiners. All digital channels shall be adjusted have the same signal level (± 1.0 dB) output before going into the first distribution amplifier and after all combiners. All digital channels shall be set a 10 dB less that the analog channels.
- E. Aural to visual carrier control: All analog channels shall be adjusted to have the same aural to visual carrier levels: -15 dB.
- F. The installer shall adjust the azimuth of each antenna to ensure the best reception possible from the transmitting station.

3.5 SYSTEM PERFORMANCE

- A. General: Upon completion the system shall be adjusted, tested, and left in perfect operating condition.
- B. Provisions: The system shall not exhibit any audible or visible components of hum, noise, or distortion.
- C. Before the system acceptance test, the installer shall test all outlets in the system and document the result in a spreadsheet, called TEST RESULT REPORT (TRR). The TTR spreadsheets shall include the following information:
 - 1. Project name and location
 - 2. Day test was done (if done in different days, the report shall be broken in sections by days the tests were done).
 - 3. Name of the installer that performed the test
 - 4. Serial number of the tester used.
 - 5. For each channel in the system the report shall include:
 - a. Channel number:
 - b. RF channel number:
 - c. Output signal level (in dBmV) measured at the output of the modulator, transcoder or processor.
 - d. Aural/Visual carrier ratio (in dBmV) measured at the output of the modulator, transcoder or processor.

3.6 REQUEST OF IP ADDRESS

A. General: The CATV installer shall follow all requirements indicated in specification section 270010 for the request of IP addresses for devices part of the CATV head end system.

3.7 SYSTEMS WARRANTY AND SERVICE

A. General: The CATV installer shall follow all warranty and service requirements indicated in specification section 270010.

3.8 ENGINEER'S FINAL ACCEPTANCE TEST

- A. General: The CATV installer shall follow all test requirements indicated in specification section 270010
- B. As part of the Engineer's final acceptance the following activities will be executed by the Engineer:
 - 1. Measure signal levels with a calibrated field strength meter at the head end system to verify the accuracy of the reading of the TRR.
 - 2. Observe picture quality at the preview monitor.
 - 3. Any other test the engineer deems necessary to establish the system is operating properly.

3.9 TEST EQUIPMENT REQUIRED

- A. Receiver: 17" minimum diagonal screen size color receiver in good working order.
- B. Meter: Signal level meter capable of measuring peak carrier levels within the 5 MHZ to 900 MHZ spectrum.
- C. Age and Calibration: Test equipment used in demonstrating system performance shall be less than 6 months old or bear the calibration seal of a recognized lab which is dated within 6 months of the date of acceptance test.

3.10 TRAINING AND INSTRUCTION

- A. General: The CATV installer shall follow all training requirements indicated in specification section 270010.
- B. The training shall include the following topics:
 - 1. How to make connectors part of this system with the provided tools.
 - 2. Signal level adjustment procedure for each channel in the head end.
 - 3. Antenna alignment procedure.
 - 4. A complete training on the use of the test tool provided.

3.11 SPARE PARTS AND TOOLS

- A. As part of this contract the installer of this system shall provide the following materials and tools:
 - 1. Ten (10) RG-6 connectors, same make and model as the units used in this project.
 - 2. Twenty (20) RG-59 connectors, same make and model as the units used in this project.
 - 3. A new and unused crimping tool for the RG-59 connector specified.
 - 4. A new and unused coaxial cable stripping tool
 - 5. Five (5) 75 Ohm terminators (f connector)
 - 6. Two (2) surge suppressors.

3.12 AS BUILT DOCUMENTS AND CLOSE OUT INFORMATION

A. General: The CATV installer shall follow all as built and close out information requirements indicated in specification section 270010.

Project No. 121505 CATV Headend Section 27 4135 - 19

- B. General: As built drawings shall include the following information:
 - 1. A block diagram of the entire system indicating all cables, cable types, active components, and passive components, with values for new as well as existing devices.
 - 2. Rack elevations with all equipment indicated
 - 3. Signal level at all input and output to all active and passive devices of the head end. All signal levels shall me indicated for the lowest frequency and the highest frequency in the system.
- C. Additional information to be provided by the CATV installer, as part of the close out information:
 1. A copy of the TRR signed approved by the A&E.

END OF SECTION 274135

SECTION 27 4136 INTERACTIVE PATIENT ROOM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes interactive patient room system. The system shall be HCI Interactive Patient Care Solution or approved equal.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment cabinets and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Cabling Diagrams: Single-line block diagrams showing cabling interconnection of all components for this specific equipment. Include cable type for each interconnection.
 - 3. Station Installation Details: For built-in equipment, dimensioned and to scale.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Field quality-control reports.
- C. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For nurse-call equipment to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Compatibility: See Integration Section in Part 3.
- C. Electrical Components, Devices, and Accessories: Listed and labeled according to UL 1069 as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.8 WARRANTY

A. Provide a warranty for the complete system to include software and programming for 12 months after Owner acceptance.

1.9 SYSTEM AND SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning with Substantial Completion, provide remote support for 3-years. If there are tiers of service provide cost for each tier. Provide annual cost to extend the support for 5 years.
- B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within three years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software. Provide this cost as a separate line item in bid.
 - 1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

PART 2 - PRODUCTS

2.1 INTERACTIVE PATIENT ROOM SYSTEM GENERAL REQUIREMENTS

A. Provide fully functional Interactive Patient Room System to provide: patient education, patient entertainment, patient engagement, room temperature controls, window blind controls, dietary food ordering, digital whiteboard, interactive television, and room status monitors. Includes all equipment, devices, in-room wiring and necessary interfaces.

2.2 SYSTEM COMPONENTS

- A. Interactive TV: 55" interactive TV with the following features:
 - 1. UL60601 listed for patient care areas. Healthcare grade TV.
 - 2. On-demand education and information to patients and family/caregivers
 - 3. Push delivery of patient-specific education plans, including education resources and discharge planning information
 - 4. Satisfaction surveys and health education comprehension testing

- 5. Hospital branding and revenue generation opportunities for auxiliary services such as Pharmacy, Gift Shop and Cafe
- 6. Access to Netflix, Hulu, Pandora and thousands of other Android Apps
- 7. Remote Network Clone and software updates from a central location
- 8. Virtual visitation / Virtual rounding via web cam / speaker and mic. Can be separate device connected to the TV
- 9. Options for control by tablet or nurse call device. Provide add alternate price for tablet and mount.
- 10. Quantity: all patient rooms
- B. Digital Whiteboard: 55" digital display interfaced with EMR and nurse call for clinician team assignments, patient alerts (fall risk, NPO etc). The digital whiteboard must be the same size as the patient TV. If the size needs to change, submit a substitution request. It is not the intent of this specification to exclude potential solution providers based on the 55" size listed. Features include:
 - a. Touch-Enabled Display Monitors a Group of Patients from a Single Location
 - b. Patient ID and Room Number
 - c. Visitor Restrictions
 - d. Care Team
 - e. Care History
 - f. InfoTiles Patient Protocols
 - g. Nurse Call Alerts: Supports as many Alerts as are needed for the patient
 - h. Admin Module
 - i. Custom Hospital Colors and Branding
 - j. Android Operating System
 - k. Portrait or Landscape Orientation
 - I. Integrates with EHR, Nurse Call, RTLS, ADT, LDAP, "Smart" Bed Systems, BMS, PAC, EVS
 - 2. Quantity: all patient rooms
- C. Room Status Monitor: Digital display (7"x10") interfaced with EMR for patient alerts (fall risk , NPO etc).
 - 1. 7"-10" tablet
 - 2. Lockable custom mount with ability to have a custom color (color selected by architect)
 - 3. Quantity: adjacent to door on all patient rooms
- D. Cable:
 - 1. Conductors: Jacketed single and multiple, twisted-pair copper cables.
 - 2. Sizes and Types: As recommended by equipment manufacturer.
 - 3. Cable for Use in Plenums: Listed and labeled for plenum installation.
- E. Grounding Components: Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems."

2.3 SOFTWARE REQUIREMENTS

- A. Integration:
 - 1. Interactive Patient Room Integrations shall include:
 - a. Nurse Call
 - b. Hospital EMR
 - c. Dietary / food ordering
 - d. CATV system
 - e. Clinical education video library

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 T Project No. 121505 Interactive Patient Room System Section 27 4136 - 3

TLC Engineering Solutions

- f. Building Automation Systems
- g. Lighting Controls
- h. Shade Controls
- i. Real Time Locating System

2.4 CONDUCTORS AND CABLES

- A. Data Cable and Hardware: Category 6 balanced twisted-pair cabling and hardware. Comply with requirements in Section 271000 "Structured Cabling System."
- B. Power Conductors and Cables: Copper, solid, No. 20 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Grounding Conductors and Cables: Copper, stranded, No. 16 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install cables without damaging conductors, shield, or jacket.
- B. Do not bend cables, while handling or installing, to radii smaller than as recommended by manufacturer.
- C. Pull cables without exceeding cable manufacturer's recommended pulling tensions.
 - 1. Pull cables simultaneously if more than one is being installed in same raceway.
 - 2. Use pulling compound or lubricant if necessary. Use compounds that will not damage conductor or insulation.
 - 3. Use pulling means, including fish tape, cable, rope, and basket-weave wire or cable grips, that will not damage media or raceway.
- D. Install exposed raceways and cables parallel and perpendicular to surfaces or exposed structural members, and follow surface contours. Secure and support cables by straps, staples, or similar fittings designed and installed so as not to damage cables. Secure cable at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, or fittings.
- E. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.
- F. Separation of Wires: Separate speaker/microphone, line-level, speaker-level, and power-wiring runs. Run in separate raceways or, if exposed or in same enclosure, provide 12-inch (300-mm) minimum separation between conductors to speaker/microphones and adjacent parallel power and telephone wiring. Provide separation as recommended by equipment manufacturer for other conductors.

- G. Splices, Taps, and Terminations: Make splices, taps, and terminations on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Install terminal cabinets where there are splices, taps, or terminations for eight or more conductors.
- H. Impedance and Level Matching: Carefully match input and output impedances and signal levels at signal interfaces. Provide matching networks if required.
- I. Identification of Conductors and Cables: Comply with requirements in Section 270553 "Identification for Communications Systems" for cable administration, cable schedule, and cable and wire identification.
- J. Equipment Identification:
 - 1. Comply with requirements in Section 270553 "Identification for Communications Systems" for equipment labels and signs and labeling installation requirements.
 - 2. Label stations, controls, and indications using approved consistent nomenclature.

3.2 GROUNDING

- A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other signal impairments.
- B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding except at connection to main building ground bus.
- C. Grounding Provisions: Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems."

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Schedule tests a minimum of seven days in advance.
 - 2. Report: Submit a written record of test results.
 - 3. Operational Test: Perform an operational system test and demonstrate proper operations.
- C. Retesting: Rectify deficiencies indicated by tests and completely retest work affected by such deficiencies at Contractor's expense. Verify, by the system test, that the total system meets these Specifications and complies with applicable standards. Report results in writing.
- D. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.
- E. Prepare test and inspection reports.

3.4 TRAINING

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel and caregiver staff to adjust, operate, and maintain nurse-call equipment.
- B. Provide six (6) separate training sessions for clinical staff. Each session should be a minimum of four (4) hours.
- C. Provide three (3) separate training sessions for Owner's IT, facility and maintenance staff responsible for the maintenance and programming of the system. Each session should be a minimum of eight (8) hours
- D. Video record training session and provide to Owner
- E. Provide training manuals (electronic copy) to Owner prior to training.
- F. Provide thirty (30) days notice to schedule training. Training must be completed prior to Final Completion.

3.5 **PROGRAMMING**

- A. Provide programming incorporating Owner's clinical staff input.
 - 1. Lead one meeting to determine a standard naming convention for all calls to be programmed in the system. The naming convention shall be used for all departments.
 - 2. Lead one meeting with each department representative to establish room naming convention, call priority, call routing, wireless phone call routing, pager call routing, workflow solutions implementation, statistical reporting implementation, and any other custom programming feature required to complete the operational programming of the system. Provide a proposed agenda and sample documentation for review prior to scheduling meetings.
 - 3. Provide 14 days notice for scheduling meetings and coordinate with the Owner's Project Manager.

3.6 INTEGRATIONS

A. Provide integration support for 12 month incorporating Owner's clinical staff input and working closely with other system vendors to deliver fully integrated and tested solutions. It is anticipated that this effort will be 80 hours per month. List any limitation in bid response

END OF SECTION 274135

SECTION 27 4137 REAL TIME LOCATING SYSTEM

PART 1 GENERAL

System Requirement Summary

A. General

Description: Provide a complete working Real-time Locating System (RTLS) infrastructure based upon the specification outlined here to include all necessary devices that provide the functions listed in this specification.

PROJECT REQUIREMENTS

This specification provides the minimum requirements for a Real-time Locating System. Thezsystem shall include all materials, labor, documentation, and services necessary to furnish and install a full-featured Bluetooth Low Energy Real-time Locating System.

Real-time Locating System and related wiring shall be furnished and installed by a certified installation contractor.

The system shall comply in all respects with all pertinent codes, rules, regulations, and laws of the hospital authority and local jurisdiction.

The system shall comply in all respects with the requirements of the specifications, and Manufacturer's recommendations.

All Real-Time Locating System sensory network devices shall have NRTL listing, as required.

The system shall support multiple integrations including nurse call systems, reporting software, wander management, EMRs, CMMS etc.

It is further intended that upon completion of this work, the Owner be provided with complete information and drawings describing and depicting the entire System(s) as installed, including all information necessary for maintaining, troubleshooting, and/or expanding the System(s) at a further date, and complete documentation of System(s) testing

SYSTEM FUNCTIONALITY

The RTLS installation shall include a lighting system that can perform real-time locating Panic Duress, in addition to occupancy, daylighting and energy monitoring

It is a requirement of the system to provide "Room level" accuracy. In addition to the capability to provide room level accuracy, it is critical that the approximate location (within 3m) be identified throughout the building by the system and relayed to the software GUI. The design for Room Level coverage assumes that room level accuracy is not required in areas that do not dictate Staff/Patient interaction, ex: restrooms, staff offices, computer rooms, workstation areas, staff classrooms, housekeeping, mechanical rooms, Electrical rooms etc. If these rooms do need the coverage, additional devices/ sensors may be required.

Project No. 121505 Real Time Locating System Section 27 4137 - 1 The system shall support a single infrastructure for:

- Staff Locating
- Asset Management
- Patient Locating
- Duress
- Workflow
- Patient flow
- Occupant-based alerting

For the system being provided, it shall be possible to improve accuracy by increasing sensor density and NOT require the addition of a discrete RTLS antenna system.

This specification describes a Real-Time Locating System using Cooper Lightings' Trellix Locate specification. It is not intended to indicate that Trellix Locate is the only acceptable solution; Other systems may be acceptable Including, but not limited to e.g., Centrak, Midmark, Sonitor, Stanley, etc. Systems other than Trellix Locate shall be approved by consultant; however, all systems shall utilize standards-based technologies such as BLE, Wi-Fi, and UWB. Systems utilizing proprietary technologies including infrared and ultrasound shall not be accepted. In addition, the system shall be capable of occupant-based alerting based on motion sensing with or without RTLS tags.

This section includes providing of BLE (Bluetooth Low Energy) Asset tags, Patient Bands, Panic Duress Badges with Buttons, Controllers, GUI/ software Application(s), Asset tracking and Geofencing. The system shall provide an open platform for integrations with the ability to securely exchange data with third parties. Any materials or equipment necessary for the proper operation of this system, whether specified or not or described herein, shall be deemed part of this system, and shall be provided unless otherwise noted.

MAINTENANCE MATERIAL SUBMITTALS

The manufacturer shall make available to the End-User a method of ordering new equipment for expansions, replacements, and spare parts through established distributor channels.

The manufacturer shall make new replacement parts available for minimum of 5 years from date of manufacture.

The manufacturer shall make directly available to the owner additional software app upgrades/patches that may be desired for a minimum of 5 years from the system's date of purchase.

The manufacturer shall provide extended support that is billable at an hourly rate OR support that can be purchased on an annual maintenance contract basis.

WARRANTY

Manufacturer's standard limited warranty from the date of product shipment:

- a. Lighting Control Devices except supervisory controller: Five (5) years limited warranty
- b. Supervisory controller: One (1) year limited warranty
- c. Tags: One (1) year limited warranty (excluding battery)
- d. Subscription service to support maintenance of the RTLS system for adding more assets, geofences, applying fixes/patches, firmware upgrades.

Installer shall provide limited workmanship warranty for one (1) year from customer acceptance. Extended warranty options may be provided for an additional charge to extend the system warranty to a total of ten (5) years. Recommended spare parts:

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 121505 Real Time Locating System Section 27 4137 - 2

TLC Engineering Solutions

- WaveLinx ceiling sensors: provide one (1) of each product type for every 200 installed, to be used for maintenance.
- Tile mount sensors: provide one (1) of each product type for every 100 installed, to be used for maintenance.
- WaveLinx wall stations: provide one (1) of each product type for every 200 installed, to be used for maintenance.
- WaveLinx receptacle: provide one (1) of each product type for every 100 installed, to be used for maintenance.
- WaveLinx relay switch pack: provide one (1) of each product type for every 200 installed, to be used for maintenance.
- Wireless Area Controller: provide one (1) of each product type for every 100 installed, to be used for maintenance.
- Low-Voltage Power Module: provide one (1) for every 100 installed to be used for maintenance
- WaveLinx touchscreens: provide one (1) of each product type for every 200 installed, to be used for maintenance.

COMMISSIONING

Provide factory-certified field service engineer to a site visit to ensure proper system installation and operation under following parameters:

Qualifications for factory-certified field service engineer:

a. Certified by the equipment manufacturer on the system installed.

Conclude commissioning with a follow-up visit to:

- a. Verify system control operation area by area.
- b. Obtain sign-off on system functions.
- b. User to be trained on system operation.

OPERATION

Basic Operation: The Real-Time Locating System should consist of tags, sensors, wireless area controllers, a server, Location engine and a web-based software application. When a BLE Tag enters a space, the tag beacons which shall be received by the sensors. The software application shall be able to display the tag's unique ID, the time the signal was received, the location of the tag, and exit/entry alerts among other alerts. If the application determines that an "unsafe" condition is present, an alarm shall be activated. The alarm can only be cancelled by authorized staff via the software application. Additionally, the application shall alert if the messages from a Tag have not been detected over a pre-defined period. The system should be capable of integrating with other systems via APIs.

Alarms: Details like location, time, and reasons for alerts are displayed and can be acknowledged. The records can be filtered and sorted.

Self-Supervisory Signals: System components shall send self-supervisory signals at specific intervals to the software application. In the case of a low battery, interference or other off-line condition, an alarm shall be displayed in the software application.

Audit Logs: The system shall provide detailed logs on users. The information includes username, source IP, time of login/logout, action (log in/logout) and the number of attempts.

User Management: The system shall support role/ permission-based security/management

Frequency: The system shall use standard 802.15.4 mesh network for communication between sensors and wireless Area Controllers.

Remote Connection: VPN (Virtual Private Network) or other connection scheme shall be made available to provide remote access for programming, training, software updates and diagnostics. email server (SMTP Protocol): Alerts can be sent to staff via email (SMTP) when there is a system alarm.

CYBERSECURITY

The IP network connectable products within the Wireless Lighting Control system must comply with the IEC 62443-4-2 cybersecurity standard. A letter of compliance by an IEC authorized certification lab shall be provided for all IP connectable product. Self-certification to the standard will not be accepted.

QUALITY ASSURANCE

Manufacturer Qualifications:

Responsible for supplying or specifying all components

Continuously engaged in wireless communication system construction with a minimum of 5 years successful experience

Able to demonstrate successful performance on comparable projects

- Responsible for system design, including:
 - Preparation of engineering and production documentation
 - Development of testing program and interpretation of test results

Capable of providing manufacturer-employed field service personnel for installation assistance. Capable of providing technical service assistance through a telephone number.

Capable of providing remote technical service after acceptance of work by the customer

PART 2 - PRODUCTS

RTLS Hardware

- 1. Acceptable Manufacturers
 - a. Cooper Lighting Solutions or other product equivalent that is acceptable to the customer Representative.
 - b. All equipment and components shall be the Manufacturer's current model. The equipment and other devices shall be tested and listed by a nationally recognized approval agency for use as a Real-time Locating System. The Manufacturer's representative shall be responsible for the satisfactory installation of the specified Real-time Locating System.
 - c. Provide, from the acceptable Manufacturer's current product lines, components and equipment that comply with the requirements of these specifications.
 - d. The Manufacturer of the System shall be regularly involved in the design, manufacture and distribution of the products specified in this document.
 - e. System infrastructure components shall be the cataloged products of a single Supplier. All products shall be listed by the Manufacturer for their intended purpose

Tags

- 1. All tags shall have a minimum of a 1-year battery life measured at a 1 second beacon rate
- 2. System shall have a 5-year battery life tag option measured at a 1 second beacon rate
- 3. System shall have a virtual tag app that can turn iOS and Android based mobile devices into tags
- 4. System shall be compatible with select third party BLE tags

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 121505 Real Time Locating System Section 27 4137 - 4

- a. Tag form factors shall include:
 - i. Staff badge with programmable button, IP66 rated
- b. Patient wrist tag with programmable button, IP67 rated
- c. Patient wrist tag with magnetic on/off switch, IP67 rated
- d. Asset tags IP67 rated
- e. Temperature and humidity sensing tag
- 5. Tag settings shall be programmable through a mobile app
- 6. Tag beacon rate shall be programmable
- 7. Tags that do not meet the preceding specifications shall not be acceptable

WaveLinx Pro Integrated Sensor [WAA]

- 1. Sensing mechanism:
- 2. [Infrared]: Utilize multiple-segmented lens with internal grooves to eliminate dust and residue buildup.Shall be capable of sending occupancy based alerts.
- 3. Location]: Utilize additional internal Bluetooth radio capable of offering Real-Time Location Services (RTLS)
- 4. Power failure memory:
- 5. Controls incorporate non-volatile memory. Settings and parameters saved in protected memory shall not be lost should power be interrupted and subsequently restored.
- Products tested in identical manner, compliant to NEMA WD 7 -2011 Occupancy Motion Sensors Standards
- 7. All sensors shall provide an LED as a visual means of indication to verify that motion is being detected during both testing and normal operation
- 8. Green LED indication when the sensor is in out-of-the-box operation mode
- 9. White LED indication when the sensor has been connected to the WaveLinx Pro lighting control system
- 10. Test mode fifteen second time delay
- 11. Walk-through mode
- 12. Sensors are RoHS compliant
- 13. Sensor shall provide out-of-the-box functionality of occupancy detection
- 14. Sensor shall wirelessly transmit occupancy status to the WaveLinx Pro Wireless Area Controller, which allows the data to be stored in a central location on-premises and displayed via the WaveLinx Pro Mobile Application and Trellix software.
- 15. Default programming is stored in each sensor in addition to the Wireless Area Controller. Sensors operate independently from Wireless Area Controller, to prevent single-point failure. Systems must operate so there is no single point of failure.

WaveLinx Pro Tilemount Sensor Kit [WTA]

- 1. Sensing mechanism:
- 2. [Infrared]: Utilize multiple-segmented lens with internal grooves to eliminate dust and residue buildup. Shall be capable of sending occupancy based alerts.
- 3. Location]: Utilize additional internal Bluetooth radio capable of offering Real-Time Location Services (RTLS)
- 4. Power failure memory:
- 5. Controls incorporate non-volatile memory. Settings and parameters saved in protected memory shall not be lost should power be interrupted and subsequently restored.
- 6. Tilemount sensor connects to a control module which supports up to 3 amps of connected fixtures or an optional 12v power supply capable of powering 2 runs of 8 sensors per run.
- 7. Tilemount is designed to be installed in a ½" or ¾" ceiling tile within 54" (137cm) of the control module and connected fixtures.
- 8. All sensors shall provide an LED as a visual means of indication and diagnostics.

- 9. Sensors are RoHS compliant
- 10. Control Module:
- 11. Sensor shall connect to a 0-10V dimmable ballast or driver via a control module, connect to a WaveLinx enabled driver without using the WaveLinx control module, or connect to a 12v power supply.
- 12. The sensor shall connect to a controller via a low-voltage cable for interior applications.
- 13. The sensor shall be FCC certified.
- 14. The sensor shall be a Class 2 device.
- 15. The system shall support user-initiated manual demand response and utility, or BMS initiated automatic demand response.

WaveLinx Pro Industrial Integrated Sensor [SWPD2 wH, SWPD3-WH]

- 1. Sensing mechanism:
- 2. [Infrared]: Utilize multiple-segmented lens with internal grooves to eliminate dust and residue buildup.
- 3. Location]: Utilize additional internal Bluetooth radio capable of offering Real-Time Location Services (RTLS)
- 4. Power failure memory:
- 5. Controls incorporate non-volatile memory. Settings and parameters saved in protected memory shall not be lost should power be interrupted and subsequently restored.
- 6. Products tested in identical manner, compliant to NEMA WD 7 -2011 Occupancy Motion Sensors Standards
- 7. All sensors shall provide an LED as a visual means of indication to verify that motion is being detected during both testing and normal operation
- 8. Green LED indication when the sensor is in out-of-the-box operation mode
- 9. White LED indication when the sensor has been connected to the WaveLinx Pro lighting control system
- 10. Walk-through mode
- 11. Sensors are RoHS compliant
- 12. Sensor shall provide out-of-the-box functionality of occupancy detection
- 13. Sensor shall wirelessly transmit occupancy status to the WaveLinx Pro Wireless Area Controller, which allows the data to be stored in a central location on-premises and displayed via the WaveLinx Pro Mobile Application and Trellix software.
- 14. Calculated energy consumption data available through Trellix
- 15. Default programming is stored in each sensor in addition to the Wireless Area Controller. Sensors operate independently from Wireless Area Controller, to prevent single-point failure. Systems must operate point so there is no sinale of failure.

WaveLinx Pro Wireless Area Controller [WAC2-POE]

- 1. A server-class gateway that allows users to discover, program, and manage WaveLinx Pro connected devices, connected sensors and connected Apps.
- 2. Power source: standardized Power over Ethernet (IEEE802.3af) input, enables building PoE network switches (by others) or a PoE injector [WPOE2-120] (accessory by Cooper Lighting Solutions) for power and network connection.
- 3. Maximum Ethernet (CAT5 or better) cable distance between the Wireless Area Controller and a network PoE switch is 328 feet (100 meters). Care shall be taken when routing the cable not to exceed the 328 feet (100 meters) limitation, including travel distance up and down structures.
- 4. The Wi-Fi access point allows users to use the WaveLinx Pro mobile app to program the system.
- The user shall be able to disable/enable the Wi-Fi access point.
 2.4 GHz Transceiver for IEEE 802.15.4 wireless radio to connect devices and sensors.
- 7. Shall support AES 128-bit encryption

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

Project No. 121505 Real Time Locating System Section 27 4137 - 6

- 8. Shall use industry-standard HTTPS security with AES-128 encryption safeguards the entire system's integrity.
- 9. LED indicators for the status of various wireless radios and communications.
- 10. Shall be FCC Part 15 Class A, RoHS certified.
- 11. Wireless Area Controller connection cables shall be plenum rated.
- 12. Shall be Class 2 devices.
- 13. Shall have IEC62443-4-2 cybersecurity certification. Self-certification will not be accepted.
- 14. Shall allow users to back up the programming to prevent data loss and restore fixtures to operational modes.
- 15. Construction Grouping
- 16. PAIR button to allow automatic creation of Construction Group allowing simplified automatic control of all connected devices and sensors.
- 17. The patent-pending Construction Grouping mode permits contractors to complete a quick system start-up to confirm that the devices have been installed correctly instead of waiting for factory-trained technicians to get the lights on a project in working order. Contractors follow a simple process to pair the wireless devices with the appropriate WAC and initiate occupancy-based lighting control functionality. This saves lighting energy during the project's construction phase by ensuring that the lights are turned off when the area is unoccupied.
- 18. Construction grouping visually indicates to the installer that devices have received wireless communication from the Wireless Area Controller and received a unique individual address. Systems that do not provide a visual indication of device connection status shall not be acceptable.
- 19. Construction grouping provides an automatic grouping of connected devices to provide simple occupancy-based and wall station control of all devices without requiring a factory-trained technician. Systems that require special software or training to group wireless devices shall not be acceptable.
- 20. Scalability and Data Integrity
- 21. The Wireless Area Controller can be deployed as a dedicated installation managing up to 150 wireless devices (connected devices, connected sensors). When deployed as a dedicated installation, the Wireless Area Controller acts as a local wireless access point for the Wi-Fi connection method to the WaveLinx Pro Mobile Application.
- 22. The Wireless Area Controller can be deployed as a network installation managing up to 150 wireless devices (connected devices, connected sensors) per Wireless Area Controller. When deployed as a network installation, the Wireless Area Controller connects to the building LAN or wireless network as a client using DHCP. The maximum number of Wireless Area Controllers on the building network depends on the building network configuration.

Trellix Core [TRX-TCENT2, TRX-TCVRT2]

- 1. An appliance that allows users to manage a connected system remotely via a web browser or mobile app.
- 2. Server shall support up to 500 Wireless Area Controllers.
- 3. Shall be able to be hosted on a virtual VMWare appliance (TRX-TCVRT2)
- 4. Shall host all applications needed to manage system, analyze the data gathered by the sensors and locate assets/personnel.
- 5. No need to install a software application.
- 6. Shall host interfaces used to exchange data with third-party system: BACnet/IP, REST API and OpenADR (for Title24 compliance).
- 7. Shall have IEC62443-4-2 certification. Self-certification will not be accepted.
- 8. Ability to store 13 months of energy and occupancy data

CONNECTED APPLICATIONS

WaveLinx Pro Mobile Application [WAPP]

- 1. Administrative programming and editing may be conducted via an intuitive iOS or Android mobile application.
- 2. WaveLinx Pro Mobile Application shall support the following features:
- 3. Network discovery of multiple Wireless Area Controllers
- 4. Naming and identification of Wireless Area Controllers
- 5. Unique administrative login credentials for each Wireless Area Controller
- 6. Discovery of wireless devices per Wireless Area Controller (Find Devices)
- 7. Creation of up to fifty (50) areas per Wireless Area Controller
- 8. Creation of up to sixteen (16) zones per area up to 200 total zones per controller
- 9. Creation of up to six (6) occupancy sets per area up to 100 total occupancy sets per controller
- 10. Creation of Demand Response values for each area
- 11. Blink identification and reverse identification of each connected device and sensor
- 12. Identified connected devices and sensors will indicate on the WaveLinx Pro Mobile Application their selection by the device icon pulsing on the screen.
- 13. Ability to utilize drag and drop, multi-select and filter capabilities for the easy association of connected devices and sensors to a defined area.
- 14. Automatic Code Commissioning features include:
- 15. Automatic association of all devices added to an area to provide a California Title 24 codecompliant sequence of operations
- 16. Automatic display of area power measurement data
- 17. Additional screens if needed to adjust Automatic Code Commissioning settings.

INTERFACE WITH OTHER SYSTEMS

The system shall be capable of interfacing to any 3rd party system capable of consuming location data, via API and/or BACnet including, but not limited to:

- 1. Nurse Call System
- 2. Visualization and alerting system
- 3. EMR
- 4. CMMS

END OF SPECIFICATION

SECTION 27 4138 RF SYSTEMS INFRASTRUCTURE

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. General: The scope of work for the Radio Frequency System (RFS) infrastructure includes a complete functional system that includes the following components:
 - 1. A self supporting antenna tower with foundation and grounding system
 - 2. All antennas and mounting hardware
 - 3. All cables for antennas
 - 4. All lighting protection and grounding system for the RF system
 - 5. All exothermic welding as required in this specifications and drawings.
 - 6. All radio equipment
 - 7. A complete RF software based integration package
- B. The following parts of the system are not part of this contract:
 - 1. All networking equipment (switches, routers, etc) for the operation of the system
 - 2. All computers and software to run the RF system with the exception of the items indicated in this specification.

1.2 RELATED DOCUMENTS

- A. General: All contract drawings and general provisions of The Contract, including General and Supplemental Conditions and Division 1 specification sections, apply to work specified in this section.
- B. General Terms and Conditions of the Contract Documents
 - 1. Division 26 Electrical
- C. Supplemental: Refer to the specification sections identified below for additional requirements, which are supplemented by this section.
 - 1. 270010 Technology General Provisions
 - 2. 270528 Raceways for Technology
 - 3. 270526 Grounding and Bonding for Communication Systems
- D. Additional codes and standards that apply to this specification section:
 - 1. R56 "Standard and Guidelines for Communications Sites" Motorola Inc. 2005.
 - 2. Lightning Protection and Grounding Solutions for Communication Sites handbook by Polyphaser Corporation

1.3 RF SYSTEM INSTALLER QUALIFICATIONS

A. The RFS installer providing the radio systems herein specified shall submit documentation, with the submittal drawings, establishing at least five years experience installing and designing radio transmission systems Provide at least seven, recent (within five years), references that can be contacted by the Owner to review performance of installed radio systems. In addition, an Associates Degree in RF Systems Engineering is required.

1.4 MATERIALS ALTERNATES AND SUBSTITUTIONS

- A. General: See details for alternates and substitution in specification section 270010 17010.
- B. There are no acceptable substitutions for any parts of this system.

1.5 SHOP DRAWINGS AND SUBMITTALS

- A. The RFS installer shall follow all requirements for shop drawings indicated in specification section 270010
- B. General shop drawing requirements:
 - 1. Proof of Installer qualifications, addressing all requirements of paragraph 1.3 of this specification.
 - 2. Submit product data for all radio equipment, antennas, cables, grounding, bonding, lightning protection and detection equipment including connectors, mounting hardware, exothermic welding equipment, clamps and other miscellaneous devices.
 - 3. Data sheets and samples of all labeling materials and equipment to be used in the project.
 - 4. A complete explanation of the identification method to be used for all equipment and cabling part of the security system.
 - 5. Test Equipment: Submit complete data on test equipment proposed for use on this project including technical specifications and a copy of the Instruction Manual.

1.6 REQUIRED RADIO AND RF SYSTEMS

- A. Radios, Antennas, Coax, and Connectors: Refer to Attachment Table A at the end of this specification for a comprehensive list of the required radio systems by frequency band.
- Β. Transmitter Building Bulkhead Panel (PEEP): The bulkhead panel provides a weatherproof cable entry method and single point grounding location for the transmitter building. It is usually located where the waveguide bridge abuts the building so that all antenna coaxial cables can enter the building in a weatherproof manner, in a straight path, the shields can be bonded to a low impedance path to the single point ground and surge suppressors can be mounted and grounded also to the same low impedance path to the single point ground. The bulkhead panel consists of copper plate with pre-punched holes for the desired number of cable entries for active antennas and anticipated future antenna needs. Each hole shall be provided with a UV weather resistant EPDM rubber boot ready to accept cable entries. The bulkhead shall be mounted on the outside of the wall and attached to the wall with stainless steel mounting hardware as directed by the manufacturer. (4) 6 inch wide solid copper straps (0.016 inch thick) shall be installed down the exterior wall and exothermically welded to the building ground near the tower base. An opening shall be provided in the exterior wall behind the bulkhead panel to allow the cables to pass through. To the back of the bulkhead panel and extending through the hole in the wall, attach a copper U-panel to mount surge suppressors and their grounding straps, to provide removable universal pre-punched protector mounting plates and for easy installation for rigid or elliptical line penetrations. Rigid transmission lines and rectangular waveguides that are too large, not circular or elliptical shall pass through the exterior wall adjacent to the bulkhead and shall be provided with antenna manufacturer's approved exterior wall penetration assemblies. Provide 1.5 inch wide solid copper strap bonding jumpers from each rigid transmission line and rectangular waveguide to the bulkhead U-panel ground on the inside of the exterior wall. Utilize approved copper grounding straps run as straight as possible with minimum bends and no sharp corners or kinks and connect with stainless steel hardware.

Project No. 121505 RF Systems Infrastructure Section 27 4138 - 2

- C. Single Point Ground: All grounding systems herein specified shall be interconnected at only one location to minimize any possibility of differential voltages and resulting current flow between systems. This single "point" (better described as "location") shall be located where the bulkhead panel ground straps connect to the building ground ring (counterpoise). All other ground systems shall connect to the ground ring immediately adjacent, or as close as possible to the bulkhead ground strap connections. Basically, there are three ground systems connected together at this location. They are:
 - 1. The power system service grounding conductor consisting of a single copper conductor #2/0 or larger.
 - 2. The tower ground ring strap via #2/0 bare stranded copper.
 - 3. The bulkhead panel solid copper ground straps consisting of two or four 6 inch wide x 0.016 inch thick straps depending on the number of antenna cable ports and connected directly to the building ground ring.

PART 2 - PRODUCTS

2.1 WIRE, CONNECTORS and CLAMPS

- A. General: Grounding and bonding wire run underground direct buried or in PVC conduit shall be bare copper, concentrically stranded, soft-drawn (annealed), Class B meeting ASTM specification B-3 and sized as shown or specified. NEC required conductors shall not be smaller than the code requires. All wire shall be manufactured in the U.S. and shall be U.L. listed.
- B. Terminations and Splices: Grounding conductors shall be terminated with high pressure compression crim xp lugs, exothermic welds or mechanical clamp connectors as shown or specified herein. Splices shall be avoided unless absolutely necessary, but where required, splices shall be constructed with only exothermic welds below ground and with high pressure compression fittings above ground.
 - 1. High pressure compression fittings and mechanical clamp fittings shall be manufactured by Burndy or equal. Exothermic welds shall be Erico's Cadweld or equal.
- C. All foam dielectric coaxial cable terminations shall be made with silver plated UHF RF connectors, soldered and crimped to manufactures specifications. If the connection is outdoors, it shall be sealed with a manufacturers approved all weather watertight silicone or similar sealant. In the even that a 90 degree turn is required on a coaxial cable run, then 90 degree 50 ohm barrel type screw on connectors shall be used. No coax is to make a bend radius smaller than that specified in the specification or by the manufacturers specification. All air dielectric coaxial connectors shall use manufacturer approved all weather sealant and shall be the approved connector to adapt down to a UHF RF connector. All coaxial cable terminations shall be installed with manufacturer approved tools and cutters. No splices are allowed at any point is the coaxial cable run.

2.2 SOLID COPPER STRAP and CONNECTORS

A. General: Solid copper strap shall be nominally 0.016 inches thick (26 AWG gage) in widths of 1.5, 3.0 and 6.0 inches and length as required, as shown or herein specified. Strap shall be C110 half-hard copper with the following characteristics:

|--|

Cross-sectional area in square inches	0.0239	0.0478	0.0956
Closest stranded wire size to the above area:	#6 AWG (0.02062)	#3 AWG (0.04134)	#2/0 AWG (0.1045)
Inductance of wire (8'):	3.362µH	3.194µH	2.961µH
Inductance of strap (8'):	2.58µH	2.22µH	1.9µH
% decrease of inductance of strap over wire (8'):	23.2%	30.5%	35.8%

- B. Installation: Strap shall be installed underground and in air as a bonding jumper as shown and as herein specified. Underground, install vertically or horizontally as required. Where cables, other strap and ground rods connect to underground strap, use only stainless steel clamp fittings designed for this specific purpose or exothermic welds. When used above ground, utilize stainless steel clamps designed for the purpose or exothermic welds. Where utilizing exothermic welds, sandwich the strap to a thickness required by the strap manufacturer to permit a proper weld. Soldering shall not be permitted. Copper strap bonding clamps and copper strap to tower leg corrosion free ground clamps shall be Polyphaser Corporation or equal.
- C. Painting: Where strap is installed on an exterior wall, such as, at the bulkhead, painting of the strap is permitted if the following procedure is followed:
 - 1. Clean and prime the copper with kits provided by the strap manufacturer.
 - 2. Weather seals all connections from moisture and corrosion with a silicone based copper joint compound.
 - 3. Clean all copper with a nylon abrasive scrub pad.
 - 4. Spray copper with self-etch primer to prevent the paint from cracking and peeling off of the copper.
- D. Manufacturer:
 - 1. Polyphaser
 - 2. or equal.

2.3 EXOTHERMIC WELD CONNECTIONS

- A. General: Exothermic welding consists of the ignition, by means of a flint igniter or electronic igniter, of powdered metals (copper oxide and aluminum) that are poured into a graphic crucible with the appropriate mold for the intended splice or connection. The reduction of the copper oxide by the aluminum produces molten copper and aluminum oxide slag. The molten copper flows over the conductors and welds them together. The weld process shall also be applicable to copperclad steel, galvanized steel, stainless steel, brass and common steel such as reinforcing bar. All materials used (molds, welding metal, tools and accessories) shall be provided by a single manufacturer. Material of different manufacturers shall not be mixed.
- B. Installation: Clean the conductors or surface where weld is to take place. Place cable(s) in mold, close and lock mold. Support mold securely or mount to surface as required. Place metal disk in mold and pour in weld metal. Sprinkle starting material over weld metal and on lip of mold. Close cover and ignite. Open mold after metal solidifies. Clean off excess slag, spurs and points so that weld is relatively smooth. Clean mold before next connection.
- C. Manufacturer:

- 1. Erico Products,
- 2. Cadweld
- 3. or equal.

2.4 GROUNDING BARS

A. General: Provide copper, ground bars in locations indicated on the contract drawings. Bars shall be ¼ inch by 4 inch by 12 inches long and predrilled with a pattern of alternating single-hole lugs and two hole lugs. Provide one inch between lugs and between top and bottom holes and edge of bar. Bolt bar to 600 volt, high strength, standoff insulators. Mount insulators to 1 inch by 7 inch U brackets that are attached to the wall with appropriate mounting studs. All hardware and brackets shall be stainless steel. Mount the bars 12 inches above floor to bottom of bar. Bar shall be approximately 2-3/4 inches from back of bar to wall. Edges of bar shall be rounded. Copper shall be C110 half-hard copper. All connections to the bar shall be with high pressure crimp lugs on the connecting cable or exothermic welds as herein specified or shown. All conductors connected to the bar shall be permanently labeled to indicate their origin and purpose.

2.5 BULKHEAD PANEL

- A. General: Provide a bulkhead panel at the exterior wall of the transmitter building where the antenna coaxial cable and waveguide enter the building. The purpose of the panel is: to provide a low impedance ground for the outside shield of the coaxial cable, and the waveguide; to provide a single point ground location; to provide a weatherproof coaxial cable entry method; to provide a low impedance grounding means for coaxial surge suppressors and to provide flanged, rigid, transmission line penetration method.
- B. Construction: Provide the bulkhead with the number of ports as specified here before. Verify exact number of ports desired before ordering to allow for future expansion equal to 50% of the current used port count. Each port shall be provided with a weatherproofing boot of EPDM +300 rubber, -60 degrees F, with UV and atmospheric stability characteristics. Boot opening shall expand to 200% to fit over cable. Bulkhead panel ports shall accommodate cable from 1/2 inch to 3-1/8 inch diameter and shall provide adjustable copper supports to position cable in center of port hole. Provide four 6-inch wide by 15 feet long copper straps from the bulkhead panel to the #2/0 AWG copper building ground ring. Straps shall be connected with a sandwich bar connection with joint compound for exothermic interconnection to the building ground ring. All hardware shall be 18-8 stainless steel and all shield clamps shall be 300 series stainless steel. Provide a copper U panel on the inside of the bulkhead panel with universal, prepunched protector mounting plates to allow for easy surge suppression installation and for rigid or elliptical line penetrations. The U panel shall allow indoor access only to the coaxial connectors and provide a low inductance grounding means for the coaxial surge suppressors. All copper shall be C110 half hard copper. All clamps to coaxial cable shields, protector grounds and waveguide grounds shall be provided with 1.5 inch, solid copper strap with appropriate connections.
- C. Offset Installations: Normally the 6 inch straps extend directly down from the bulkhead panel to the building ground ring with no offsets. Where this is not feasible (door or opening under the bulkhead panel, for instance) provide a grounding bar system attached to the bottom of the bulkhead panel and extended horizontally to allow the 6 inch straps to be mounted directly from the ground bar to the building ground ring.
- D. Manufacturer: Bulkhead panel system shall be manufactured by:
 1. Polyphaser Corporation

2. or equal.

2.6 COAXIAL INLINE SURGE SUPRESSORS

- A. General: Coaxial shield grounding straps provide a layer of protection in the event of a lightning strike. In addition, inline coaxial and waveguide surge protectors shall be installed to provide a grounding path for surge currents which penetrate to the center coaxial conductor. Surge protectors shall be sized and selected for the specific signal type, frequency, coax type, and power handling requirements of each coaxial feed. DC continuity protectors or injectors will be needed for tower top amp power supply. Specially sized combiner filters will need to be selected based on the total transmit power of the combined transmitters to that normal operation does not trigger the protection device. Protectors shall be selected to match the impedance (50 or 75 ohm) of the feed line, source, and load antenna.
- B. Construction: Mount all coaxial inline protectors on the inner side of the coax penetration bulkhead mounting surface. Provide 2" flat copper straps from the protector housing to the bulkhead panel and attach with high pressure clamps. The ground path for the surge protectors shall be through the bulkhead panel to the ground bus bar outside the building and down the copper straps to the single point ground at the building ground ring. DO NOT connect the bulkhead ground to the electrical bus bar in the radio room where the penetration plate enters the building. Doing so shall induce a ground loop, allow surge current into the building ground conductors, and nullify the single point ground system.
- C. Manufacturer:
 - 1. Polyphaser
 - 2. or equivalent.

2.7 GROUNDING STRAPS FOR COAXIAL and WAVEGUIDE SHIELD BONDING

- A. General: Coaxial shield and waveguide enclosure grounding is required at intervals, as specified for the length of run from the antennas to the base of the tower in order to provide an effective ground path to prevent energy from reaching equipment. Hangers for the waveguide and rigid coaxial transmission lines are spring supported and are not low impedance grounding paths. Also, lightning strikes to the side of the tower will dissipate and be more evenly distributed by grounding the antenna lines at regular intervals.
- B. Construction: Grounding straps shall be copper and have shield clamps to fit cables from ¼ inch in diameter to 4 inches in diameter. Connections to waveguides require strap-to-double nut connectors. The strap shall be adjustable to the cable angle and shall be 24 inches long. Provide the proper size and type of grounding fitting to connect the strap to the tower to prevent dissimilar metal connections. Strap and clamps shall be weatherized with non-conductive, water impermeable (MIL-S-19653A), UV and salt spray resistant covering to withstand –65 degrees to 180 degrees F without cracking. Strap and fittings shall be rated 680 µohm resistance, 0.3µ henries inductance, 50 ka surge withstand and provide a total voltage drop of 763V (based on 20 ka, 8/20 µ.s. strike).
- C. Manufacturer: Cable grounding kits and weatherproofing shall be:
 - 1. Polyphaser Corporation
 - 2. or equal.

2.8 COAXIAL CABLE

- A. See Attachment Table A for coax size requirements per frequency.
- B. All coaxial cable shall be labeled on the outer jacket with a unique serial number on the entire installed length at intervals of every 6 feet. A matrix shall be created that shows the origination, destination, and frequency of operation for each cable. The owner should at the completion of the project be able to identify each run of coax at each service location by referring to the serial number and matrix.
- C. 7/8" coax located OUTSIDE of plenum space for conduction of RF signals and utilized for direct connection to radio devices shall have the following characteristics:
 - 1. 50 ohm characteristic impedance
 - 2. 7/8" minimum outer diameter
 - 3. Foam dielectric
 - 4. Rated for 1000 RF watts or greater at 1GHz
 - 5. Constructed of corrugated copper tube inner and outer conductors
 - 6. Abrasion resistant jacket
 - 7. Flame and fire retardant jacket
 - 8. Ultraviolet resistant jacket
 - 9. VSWR less than 1.2:1
 - 10. Attenuation less then 5dB per 100 meters at 1GHz
 - 11. Design selection: RFS 7/8" CellFlex UCF78-50JFN or equal
- D. 7/8" coax located INSIDE of plenum space for conduction of RF signals shall have the following characteristics:
 - 1. Plenum rated
 - 2. 50 ohm characteristic impedance
 - 3. 7/8" minimum outer diameter
 - 4. Air dielectric
 - 5. Rated for 1000 RF watts or greater at 1GHz
 - 6. Constructed of copper tube inner and outer conductors
 - 7. Abrasion resistant jacket
 - 8. Flame and fire retardant jacket
 - 9. Ultraviolet resistant jacket
 - 10. VSWR less than 1.2:1
 - 11. Attenuation less then 5dB per 100 meters at 1GHz
 - 12. Design selection: RFS 7/8" Heliflex HCA8-50JPL or equal
- E. All RG6-QS used in the project shall be: Belden #1189AP quad shield, 75 ohm, plenum rated coax, or an exact specification equivalent.

2.9 RADIOS

A. See attachment table A for detailed radio requirements, antennas, and support infrastructure for all radio systems.

2.10 ANTENNAS

- A. See attachment table A for detailed antenna requirements for each system.
- B. All antennas and brackets for this project shall be rated at 150 Mph winds.

- C. All antennas shall be provided with proper brackets and stand offs for clamping to antenna tower.
- D. The RF system installer shall provide as part of the submittals a cut sheets of all antennas to be used and all mounting accessories. The installer shall also send a proposed layout of the mast indicating the mounting height for each antenna.

2.11 INTEGRATION SYSTEM

- A. General: The RF system installer shall provide a complete integration package that shall provide the following features:
 - 1. Access to all radio systems from any of the phone sets.
 - 2. Allow to play radio communications from any of the radio units in the project in the paging system.
 - 3. Provide the proper signaling to the Fire Station Alerting system (see paging system specification 275113) for selective call and all call from dispatch center.
- B. The performance requirements for this system are:
 - 1. A phone system user shall be capable of accessing any of the radio systems in the project by dialing a unique extension number in the phone system. Once connect to the radio system, the integration system shall allow for half duplex communications between the user at the phone set and the radio system. Communication shall be terminated to the radio system by hanging up the phone call and this process shall free the radio system to other users.
 - 2. An EMS dispatch call from the 800 MHz system for First Responders shall provide audio and signaling to the Fire Station Alerting system for all automated events. A separate set of contacts for signaling shall be used this event different from other events like crash phone activation or fire department dispatch.
- C. The integration system shall be based on different hardware and software components to make a complete functional system. These are some of the components of the system:
 - 1. Networking equipment (IP infrastructure). New and existing infrastructure shall be used to transport the information. See specification section 272100 Data Network Equipment and design drawings.
 - 2. Audio gateways for radio systems. Radio systems shall be tied to the IP network through audio gateways. Design selection: VoiceInterop AudioMate 360r with rack mounted power supply and rack kit or approved equal.
 - 3. Audio gateways for paging system and fire station alerting system. The paging system and the Fire Station Alerting system shall be tied to the IP network through audio gateways. Design selection: VoiceInterop AudioMate 360a with rack mounted power supply and rack kit or approved equal.
 - 4. Phone sets: VoIP phone sets part of a phone system shall be provided as part of this project as indicated in design drawings.
 - 5. Integration software: The integration software shall allow the communication of all these different devices, as well as establishing priorities and communication patch between devices. Design selection: Twist Pair WAVE software or approved equal.
 - 6. Servers and workstation: As required for the integration software for proper operation and user interface.

2.12 IDENTIFICATION AND LABELING TAGS

A. The RFS installer shall follow labeling materials indicated in specification section 270010

PART 3 - EXECUTION

3.1 INSTALLATION PRACTICES

- A. General: The RFS installer shall follow all installation practices indicated in specification section 270010.
- B. General: All coaxial cables and components shall be installed in a neat, workmanlike manner avoiding any sharp bends or splices. Underground conductors shall be run straight at possible with no coiling or excess conductor. Conductor terminations shall be trimmed and dressed to eliminate excessive tails, sharp points, excess slag from exothermic welds and burrs. All clamp connectors shall be made up tight and all bolts and screws shall be marked with a permanent marker to indicate first, that it has been tightened to final position and second to provide an indicator to show that the screw or bolt has been rotated.
- C. Coaxial Cable: All coaxial cable shall be installed observing the manufacturers specified bend radius or as indicated below, whichever is greater:
 - 1. 7/8" coax shall have be installed with a bend radius of no less than 8"
 - 2. Where bend radius cannot be observed, a 90 degree UHF connector shall be installed to complete the connection path.
- D. Exothermic Welds: Exothermic welds shall be performed in strict compliance with manufacturer's instructions and as follows:
 - 1. Wherever an exothermic weld has caused degradation to the galvanized finish of surfaces to which grounding or bonding conductors are attached, repair the galvanized surfaces either with a re-galvanizing, 97% zinc rich organic coating or with a galvanizing bar of low temperature, self fluxing material if sufficient heat remains after the weld to melt the bar or a small torch may be used.
 - 2. Utilize a cleaning solvent (methylene chloride) to thoroughly wash oil or grease from cable strap, bus bar or steel surfaces before welding.
 - 3. Inspect all exothermic weld connections to assure it is a good weld based on the following indicators:
 - Color: The color of a welded connection is best ascertained after a light wire brushing of the connection. It should normally be gold to bronze in color. Occasionally, it may be silvery at the top. This silver color indicates "tin sweat" of the surface, a normal condition. A welded connection to cast iron or galvanized surfaces is often silvery due to alloying with the metals.
 - b. Surface Finish: The surface of a welded connection shall be reasonably smooth and free of major slag deposits. Slag deposits covering more than 20% of the connection surface, or when removed, expose any cable strands shall cause rejection of the connection. Do not confuse surface slag with the normal slag present on the top (riser section) of welded connections.
 - c. Porosity: The connection shall be essentially free from porosity. A few small pinholes may be present on the surface of the riser, which, if probed with a 1/32" diameter wire (paper clip) shall not penetrate to a depth which will extend beyond the center of the conductor. Excessive porosity is normally the result of contaminants (water, oil, dirt, etc.) in the conductor and/or mold.
- E. Trenches: Trenches shall be dug reasonably neat and straight. Bottoms of trenches shall be free of rocks. When laying conductor in trenches, make sure conductor is reasonably centered in trench and that fill material is free of rocks, roots or other objects that might impinge on the conductor. Fill shall be compacted to 95% compaction. Where conducting concrete is utilized to enhance ground resistivity, follow manufacturer's instructions and recommendations. Clear away underbrush in area where trench is to be dug and replace surface cover after backfilling to

Project No. 121505 RF Systems Infrastructure Section 27 4138 - 9 avoid soil corrosion. If possible, keep trenches away from trees, preferably beyond the drip line. If this is not possible, trenches may be located up to six feet from the tree trunk, but no closer. Where it is necessary to run the trench closer than 6 feet to a tree, remove the tree.

3.2 SYSTEM WARRANTY AND SERVICE

A. General: The RFS installer shall follow all warranty and service requirements indicated in specification section 270010.

3.3 ENGINEER'S FINAL ACCEPTANCE TEST

- A. General: The RFS installer shall follow all test requirements indicated in specification section 270010.
- B. Additional testing requirements for the RF system:
 - 1. All antenna feed lines shall be RF swept with TDR to determine proper installation without kinks or damage to the coax
 - 2. All antenna and radio systems shall be tuned to a final SWR reading of no more than 1.8:1.
 - 3. All halo ground systems shall be tested to ensure an adequate ground connection for 60Hz power and lighting protection. A ground path resistance of less than 5 ohms is required.

3.4 CONDUCTOR IDENTIFICATION

- A. General: All ground system conductors connected to ground bars and switchboard ground bus shall be permanently and legibly labeled at both ends as to function and specific location of grounded device (i.e. Tenant #1 ground bar). Ground connections of a common purpose shall be grouped together on a common ground bar or bus as follows:
 - 1. Surge Producers such as Interior Broadcast equipment, cable entrance ground bar, MDF bar, generator frame, etc.
 - 2. Surge Absorbers such as main AC service neutral, building service ground, water pipe, building steel, UFER ground, etc.
 - 3. Common Bonding Network such as broadcast racks, battery rack and rectifier, etc.
 - 4. Isolated Bonding Network such as logic returns, framework grounds, etc.
 - 5. In no case shall surge suppressor "protected" cable mix with "unprotected cable or grounding conductors".
- B. All RF lighting protection devices shall be clearly labeled with the frequency of operation and the radio and antenna system they are connected to.
- C. All coaxial connections of RF bulkhead patch panels shall be clearly labeled so that each run may be identified from either end, but not is such a way that precludes flexible coax usage. I.E. simple 1, 2, 3 number system will suffice.

3.5 UFER GROUND SYSTEM

A. General: The copper conductor utilized in the UFER ground system shall be installed so that it is no closer than 3 inches from the bottom, sides or top of the concrete foundation. Locate the

UFER ground at the single point ground location and bond the copper conductor to the building ground ring with exothermic weld at the single point ground location.

3.6 TRAINING AND INSTRUCTION

A. General: The RFS installer shall follow all training requirements indicated in specification section 270010.

3.7 AS BUILT DOUCMENTS AND CLOSE OUT INFORMATION

- A. General: The RFS installer shall follow all as built and close out information requirements indicated in specification section 270010
- B. Additional requirements for as built documentation shall include:
 - 1. Accurate as-built drawings showing all underground cable routings and ground rod locations.
 - 2. Digital pictures of all underground work, including all exothermic welds, ground rods, installation of conducting concrete, copper strap and strap connections, single point ground, main switchboard ground bus ground connections, tower base anchor bolt and re-bar grounding, guy anchor grounding and other installation documentation not observable after installation is complete. Key all pictures into the as-built plans and provide all files in electronic format
- C. Close out information shall also include:
 - 1. Completed Soil Resistivity Data Sheet.
 - 2. Completed 3-point Fall of Potential Test Data Sheet.

3.8 ATTACHMENTS

A. ATTACHMENT A

DESCRIPTION	RADIO	CABLE	ANTENNA
800 MHz system (806- 821 MHz) for Port Au- thority Communications	Motorola Astro XTL 5000 Consolette P25 10-35W 762-870 MHz local control, with enhanced software Astro CAI operation, smartzone system software, P36 9600 baud trunking, W7 hardware setup con- solette, express service plus, tone con- trol remote and enhanced ID display	7/8" superflex transmission line.	6dB, 806-960 Mhz, weatherproof yagui, heavy duty antenna, 3 ele- ments with N con- nector.

800 MHz system (806- 821 MHz) for Lee Coun- ty Communications.	Motorola Astro XTL 5000 Consolette P25 10-35W 762-870 MHz local control, with enhanced software Astro CAI operation, smartzone system software, P36 9600 baud trunking, W7 hardware setup con- solette, express service plus, audio infc db XTL5000 and enhanced ID display	7/8" superflex transmission line.	8.6dB, 806-960 Mhz, weatherproof yagui, heavy duty antenna, 5 ele- ments with N con- nector
One VHF system (150- 171 MHz) with 128 channels	Motorola Astro XTL 5000 Consolette P25 10-50W 136-174 MHz local control, with enhanced software Astro ready analog operation, conventional operation, W7 hardware setup consolette, express ser- vice plus, tone remote control and en- hanced ID display	7/8" superflex transmission line.	3 dB 147 to 174 MHz weatherproof omni directional antenna vertical dipole. N connect- or
Avionic communications (117.975 to 137 Mhz)	ICOM VHF air band transceiver 118 to 136 MHZ – 36W . model IC-A210. With rack mounted power supply	7/8" superflex transmission line.	3dB 100 to 156 MHz omni direc- tional antenna ver- tical dipole. N connector
Pager system 154.430MHz	Motorola Minitor V	7/8" superflex transmission line.	Unity gain 144 to 174 MHz omni directional anten- na vertical dipole. N connector

END OF SECTION 274138
SECTION 27 5113 PUBLIC ADDRESS/BACKGROUND MUSIC SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. General: The following documents, apply to work of this section:
 - 1. 270010 Technology General Provisions
 - 2. 270528 Raceways for Technology
 - 3. 271000 Structured Cabling System
 - 4. 270526 Grounding and Bonding for Communication Systems
- B. General: Telecommunications Drawings apply to work of this section. The overall and detailed Public Address/ Background music system referred hereinafter as the PA system design shown on the drawings, selected materials, device locations, installation details, mounting details, cabling routing and supporting and all technical specifications if provided on the drawings apply to work of this section.
- C. General: Installation practices for PA system as describe herein take precedence over any other section in the construction documents set.

1.2 SCOPE OF WORK

- A. The PA System (PAS) Installer shall be responsible for the complete installation of the PA System, including but not limited to the provision, fabrication and installation of the amplifier racks, microphone switching unit, microphone stations, microphones, all speakers, speaker enclosures, baffles, the wiring of all components, interfacing to existing equipment and testing/adjusting of the complete PA System.
- B. For all raceways part of the PA system, see specification section 270528.

1.3 SYSTEM DESCRIPTIONS AND REQUIREMENTS

- A. The PA system is composed of the following components and subsystems:
 - 1. Paging stations
 - 2. Microphone audio/control distribution system
 - 3. Audio switching and control system.
 - 4. Digital Signal processing systems and components
 - 5. Power amplifiers
 - 6. Speakers
 - 7. Test and monitoring system and components
 - 8. Racks, cabinets and accessories.
- B. When the proposed system uses structured wiring infrastructure, including but not limited to premises UTP or STP cable, fiber optic cables, backbone copper cables, patch panels, telecommunications outlets, punchdown blocks; all specifications given in section 271000 shall apply to this part of the work.

1.4 INSTALLER QUALIFICATIONS

- A. General: The PAS installer selected for the Project must be certified by the manufacturers of the products, adhere to the engineering, installation and testing procedures and utilize the authorized manufacturers components and distribution channels in provisioning the Project.
- B. General: The PAS installer directly responsible for this work shall be a "Audio Visual System Installer" who is, and who has been, regularly engaged in the providing and installation of commercial and industrial audio visual systems of this type and size for at least the immediate past five years. Any sub Installer who will assist the PAS installer in performance of this work, shall have the same training and certification as the PAS installer.
- C. Certification: The PAS installer's Project Manager shall possess a current BICSI Registered Communications Distribution Designer (RCDD®) certificate or an ICIA® Certified Technology Specialist (CTS) designation. All shop drawings submitted by the installer shall bear the RCDD's stamp or the name of the CST.
- D. Experience: The Installer shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size. The Installer shall own and maintain tools and equipment necessary for successful installation and testing audio visual systems and have personnel who are adequately trained in the use of such tools and equipment. The Owner or engineer may elect to request submittal of additional financial, operational and administrative information of the installer to demonstrate the required experience.
- E. A current certificate of insurance meeting the Owner minimum insurance requirements.

1.5 MATERIALS ALTERNATES AND SUBSTITUTIONS

- A. General: See details for alternates and substitution in specification section 270010.
- B. Substitutions are allowed for this system as long as all substitutions do not represent and change in architecture and have exactly the same performance as the basis of design

1.6 SHOP DRAWINGS AND SUBMITTALS

- A. The PAS installer shall follow all requirements for shop drawings indicated in specification section 270010
- B. General: Submittals shall include manufactures cut sheets for all proposed equipment. Cut sheets shall bear the printed logo or trademark of the manufacturer for each type of product being provided. Mark each copy of the data sheets for the specific product being provided with an identifying mark, arrow, or highlighting. The followings items shall be submitted:
 - 1. All wire and cable.
 - 2. All connectors and required tooling.
 - 3. All termination system components for each cable type.
 - 4. All Active and passive hardware components.
 - 5. All software components
 - 6. All grounding and surge suppression system components for the systems portion of the project.
- C. A resume of qualifications shall be submitted with the installer's bid indicating the following:

- 1. A list of recently completed projects of similar type and size with contact names and telephone numbers for each.
- 2. A list of test equipment proposed for use in verifying the integrity of the installed distributive information local area network system.
- 3. A technical resume of experience for the installer's engineer/RCDD and on-site foreman who will be assigned to the project.
- 4. Similar documentation for any sub installer who will assist in the performance of this work.

1.7 WORK EXTERNAL TO THE BUILDING

A. General: Any work external to the confines of this building as shown on the drawings shall be governed by the provisions of this specification.

PART 2 - PRODUCTS

2.1 PAGING STATIONS

- A. General: The purpose of the paging stations is to initiate a page in the system. Refer to design drawings to identify the different types of paging stations.
- B. The microphone of the paging stations shall be a dynamic microphone with a cardioid (unidirectional) pickup pattern to suppress unwanted background noise. The frequency response of the microphone shall be at least from 40Hz to 10KHz. The sensitivity of the microphone at 1KHZ shall be as follow:
 - 1. Low level: -57.5 dB (1.3 mV).
 - 2. High level: -38.5 dB (12 mV)
- C. The microphone mounting depends on the type of paging station. The type of microphone mounting, according to the different paging stations types are:
 - 1. For type 1 paging stations: The microphone shall be mounted as desktop base station type.
- D. The base of the paging station could have one or more "push to talk" buttons, a 12 button keypad, an LCD display, a speaker and one or more LED indicators, depending on the type of paging station. The type of base according to the different paging stations types are
 - 1. For type 1 paging stations: The base shall have a 12 button keypad, a X line by Y character LCD display, a 4" speaker, the following LED indicators: a green (ready) and a red (busy), for a desktop application.
- E. When paging stations require a non-standard (standard meaning a gangable electrical box) backbox for the installation, the PAS installer shall provide them as part of this contract. The PAS installer shall provide as well any other accessories required for the correct operation or mounting of the page stations, including but not limited to power adapters, mounting clips, connectors, anchors, etc.

2.2 MICROPHONE AUDIO/CONTROL DISTRIBUTION SYSTEM

- A. The audio and control signals from the paging stations to the audio switching and control systems shall be transmitted by analog means to an Ethernet gateway, and from this gateway shall use digital means to get to the audio switching and control system.
- B. Audio signals shall be distributed from the paging station to the Ethernet gateway by means of a twisted pair 100% shielded cable, made of stranded copper conductors with a AWG-22 Tinned copper drain wire. The gauge of this cable shall be selected according to the distance of the cable run, to ensure a less than 5% of signal loss. The jacket of this cable shall be rated as CMR or CMP if installed in plenum environments.
- C. Control signals shall be distributed from the paging station to the Ethernet Gateway by means AWG-22 twisted pair 100% shielded cable, made of stranded copper conductors with an AWG-22 Tinned copper drain wire. The jacket of this cable shall be rated as CMR or CMP if installed in plenum environments.
- D. For desktop mounted paging stations, the above mentioned cables shall be terminated in an outlet box with XLR type connectors. The paging stations shall have a flexible cord or a rubber insulated cable terminated with the corresponding mating connectors in the paging station and the outlet box.
- E. The Ethernet gateway shall be a multiple input device (quantity of inputs as indicated on design drawings) capable of delivering hi fidelity audio signals to the audio switching and control system by means of an Ethernet network. The specifications of the Ethernet gateway are:
 - 1. Signal types: It shall be able to upload microphone or line level analog audio signals.
 - 2. Power: It shall be capable of sending 48 VDC phantom power to the paging stations.
 - 3. Frequency response: 20 Hz 20 KHz with a +4 dBU input signal.
 - 4. Total harmonic distortion: 0.01% @ 1KHz with a +4 dBU input signal.
 - 5. Dynamic range: 78 dBA for mic level signals, and 95 dBA for line level signals
 - 6. Input gain: software controllable from -9 dB to +60 dB, in 1 dB increments.
 - 7. A/D quantization: 24-bit resolution.
 - 8. Audio sampling: 48 KHz
 - 9. Communication protocol: Cobranet[™] over 100Base T Ethernet link.
- F. The wiring of the system from the Ethernet gateway to the audio switching and control system shall be by means of UTP cable or fiber optics, according to design drawings. The PAS installer shall follow all specifications of section 271000 to do this wiring.
- G. All networking equipment required to communicate from the Ethernet gateway to the audio switching and control system, including but not limited to switches, routers, media transceivers or gateways shall be provided by the PAS installer.
- H. The audio and control signals from the paging stations to the audio switching and control systems shall be transmitted by UTP or fiber optic cables as indicated in the design drawings. The PAS installer shall follow all specifications of section 271000 to do this wiring.

2.3 AUDIO SWITCHING AND CONTROL SYSTEM

A. General: The purpose of the Audio switching and control system is to route the page announcements from the paging stations to the user selected output zones.

2.4 DIGITAL SIGNAL PROCESSING SYSTEM AND COMPONENTS

- A. General: The purpose of the digital signal processing system is to filter, limit, or alter the original audio input on any desired way to enhance the audio response of the page announcement or background music by means of DSP active equipment.
- B. The digital system processing system shall be 100% software controllable with 4 or 8 multiple audio inputs and outputs. The control software shall be installed on a standard PC, and shall provide complete display and control in graphical form, of all signals processing configurations and functions. Once the system is programmed, the unit shall be capable of storing the configuration in non-volatile memory.
- C. The digital signal processing system shall be configurable to utilize a variety of signal processing algorithms, including but not limited to:
 - 1. Input and output gain control with meters.
 - 2. Parametric bandpass, all-pass, high and low shelf & cut filters.
 - 3. Feedback suppression.
 - 4. Graphic equalization
 - 5. Crossovers
 - 6. Compression, limiting, automatic gain control, ambient noise compensation.
 - 7. Mix, select, level control and delay.
 - 8. Pink noise and sine wave generation.
- D. The data conversion of the digital signal processing system shall be 24-bit, 48 KHz sampling rate.
- E. The unit shall meet UL/CSA and CE safety requirements.

2.5 POWER AMPLIFIERS

- A. General: The purpose of the power amplifiers is to amplify all audio signals to be transmitted to the speakers. The power amplifier shall be a 70V direct constant voltage unit with the following features:
 - 1. Power supply shall be of the switching type.
 - 2. Rack mountable with cooling fans for front to back, or side to side ventilation.
 - 3. Input sensitivity independent for each channel.
 - 4. Unit shall have protection circuits for amplifier overheat, shorted outputs, DC, mismatch loads, under/over voltage, high frequency overloads and internal fault.
 - 5. Switchable high-pass filter per channel, to eliminate step down transformer saturation at low frequencies.
 - 6. Comprehensive indicators array for Power, Data, Read, Signal, Thermal and Fault.
 - 7. Unit shall be UL listed
- B. Power handing: All amplifiers shall be seized to handle 75% of the total load of the speaker's line.
- C. The audio handing performance of the power amplifiers shall be:
 - 1. Frequency response: 20Hz to 20Kkz ± 1dB @ 75% of the rated power.
 - 2. Signal to Noise ratio: 105dB A-weighted below power rating from 20Hz o 20KHz.
 - 3. Total Harmonic Distortion (THD): <0.4% @ rated power from 20HZ to 20Khz.
 - 4. If unit has two or more channels. Crosstalk: >80dB, below rated power from 20Hz to 1KHz.
 - 5. Common mode rejection ratio (CMRR): >40 dB from 20Hz to 20KHz.
 - 6. Damping factor: >1000

- D. Amplifiers shall be of switching type.
- E. Amplifier shall be capable of being monitored from the test and monitoring system through an 100Mb Ethernet connection.

2.6 SPEAKERS

- A. General: All speakers shall include a 70V transformer. Speakers are classified in types according to the location where they will be installed. The design drawings indicate all different types and locations in the floor plan.
- B. SPEAKER TYPE 10: This speaker type shall be used for ceiling lower than 10 ft. high. This speaker could be mounted in dry-wall or lay-in ceiling applications. Speaker type 10 shall have the following specifications:
 - 1. Speaker: 4" coaxial loudspeaker with a 25W power rating
 - 2. Woofer construction: Poly cone butyl rubber.
 - 3. HF driver construction: PEI dome tweeter.
 - 4. Frequency response: 75Hz to 20Khz
 - 5. Sensitivity: 88 dB average.
 - 6. Magnet weight: minimum of 10 oz.
 - 7. Voice coil diameter: 1 inch
 - 8. Transformer tabs: 1,2,4,8 and 16 W.
 - 9. Enclosure: acoustically treated, front loading with a minimum depth of 7".Unit shall have conduit knockouts, and shall include all mounting accessories like plaster rings, trim rings, and tile bridge.
 - 10. Grill: shape, finish and color shall be coordinated with the architect.
 - 11. Basis of design: Atlas soundolier model FAP42T
- C. SPEAKER TYPE 11: This speaker type shall be used for ceilings between 16 ft. and 10 ft. high. This speaker could be mounted in dry-wall or lay-in ceiling applications. Speaker type 11 shall have the following specifications:
 - 1. Speaker: 6" coaxial loudspeaker with a 50W power rating
 - 2. Woofer construction: Poly cone butyl rubber.
 - 3. HF driver construction: PEI dome tweeter.
 - 4. Frequency response: 63Hz to 20Khz
 - 5. Sensitivity: 88 dB average.
 - 6. Magnet weight: minimum of 14 oz.
 - 7. Voice coil diameter: 1 inch
 - 8. Transformer tabs: 2,4,8,16 and 32 W.
 - 9. Enclosure: acoustically treated, front loading with a minimum depth of 7".Unit shall have conduit knockouts, and shall include all mounting accessories like plaster rings, trim rings, and tile bridge.
 - 10. Grill: shape, finish and color shall be coordinated with the architect.
 - 11. Basis of design: Atlas soundolier model FAP62T
- D. SPEAKER TYPE 12: This speaker type shall be used for ceilings between 25 ft. and 16 ft. high. This speaker could be mounted in dry-wall or lay-in ceiling applications. Speaker type 12 shall have the following specifications:
 - 1. Speaker: 8" coaxial loudspeaker with a 70W power rating
 - 2. Woofer construction: Polypropylene cone & SBR surround.
 - 3. HF driver construction: PEI dome tweeter.
 - 4. Frequency response: 55Hz to 20Khz
 - 5. Sensitivity: 90 dB average.
 - 6. Magnet weight: minimum of 21 oz.

- 7. Voice coil diameter: 1 inch
- 8. Transformer tabs: 1.9, 3.8, 7.5, 15, 30 and 60 W.
- 9. Enclosure: acoustically treated, front loading with a minimum depth of 7".Unit shall have conduit knockouts, and shall include all mounting accessories like plaster rings, trim rings, and tile bridge.
- 10. Grill: shape, finish and color shall be coordinated with the architect.
- 11. Basis of design: Atlas soundolier model FAP82T
- E. SPEAKER TYPE 13: This speaker type shall be used for ceilings between 50 ft. and 25 ft. high. This speaker could be mounted in dry-wall or lay-in ceiling applications. Speaker type 13 shall have the following specifications:
 - 1. Speaker: 12" coaxial loudspeaker with a 250W power rating
 - 2. LF driver construction: 12" diaphragm.
 - 3. HF driver construction: 2.5" diaphragm with 20 oz magnet.
 - 4. Frequency response: 33Hz to 21Khz
 - 5. Sensitivity: 117 dB average.
 - 6. Magnet weight: minimum of 70 oz.
 - 7. Voice coil diameter: 2.5 inch
 - 8. Transformer tabs: 7.5,15,30 and 60 W.
 - 9. Enclosure: acoustically treated, front loading with a minimum depth of 15". Unit shall have conduit knockouts, and shall include all mounting accessories like plaster rings, trim rings, and tile bridge.
 - 10. Grill: shape, finish and color shall be coordinated with the architect.
 - 11. Basis of design: Atlas soundolier model 12CXT60 with Q4812 enclosure
- F. SPEAKER TYPE 20: This speaker type shall be used for wall mount applications in small rooms. Speaker type 20 shall have the following specifications:
 - 1. Woofer Speaker: 5.25" polypropylene cone with rubber surround and 20 oz. magnet
 - 2. Tweeter speaker: 1" Mylar diaphragm with a 1.39 oz. magnet.
 - 3. Frequency response: 85Hz to 20Khz
 - 4. Sensitivity: 90 dB average.
 - 5. Transformer tabs: 0.94, 1.9, 3.7, 7.5, 15 and 30 W.
 - 6. Accessories: mounting bracket included.
 - 7. Color: black or white, selection by architect.
 - 8. Basis of design: Atlas soundolier model SM52T
- G. SPEAKER TYPE 21: This speaker type shall be used for wall mount applications in large rooms. Speaker type 21 shall have the following specifications:
 - 1. Woofer Speaker: 8" hycone treated paper cone with treated cloth surround and 30 oz. magnet
 - 2. Tweeter speaker: 1" titanium diaphragm with a 13 oz. magnet.
 - 3. Frequency response: 65Hz to 20Khz
 - 4. Sensitivity: 92 dB average.
 - 5. Transformer tabs: 1.9, 3.8, 7.5, 15, 30 and 60 W.
 - 6. Accessories: mounting bracket included.
 - 7. Color: black or white, selection by architect.
 - 8. Basis of design: Atlas soundolier model SM82T.

2.7 TEST AND MONITORING SYSTEM AND COMPONENTS

A. General: The purpose of the test and monitoring system is to allow the system's user to test and troubleshoot the PA system.

- B. The test and monitoring system shall be capable of monitoring and testing the following subsystems of the PA system:
 - 1. Paging stations (Only in IED systems)
 - 2. The microphone audio/control distribution system (Only for IP based systems)
 - 3. The audio switching and control system.
 - 4. The digital signal processing system.
 - 5. The Power amplifiers
 - 6. The speaker lines coming out of the amplifier.
- C. The paging stations shall be capable on creating an audio tone that will be tested throughout the complete PA system line to check all components. The tone shall be triggered by the test and monitoring system automatically and the time and dates for those events shall be programmable. (For IED systems)
- D. The PA system shall have a paging station and a rack mounted speaker at the headend location for troubleshooting purposes. From this page stations it shall be possible to do local pages in each system zone as well as any other type of general pages that are available in other stations in the system.
- E. The audio hubs in the microphone audio/control distribution system shall be capable of testing through the IP network by means of a ping command. The units shall also have indicators builtin to display the strength of the audio signal coming in or out of the unit. (For IP based system)
- F. The audio switching and control system as well as the digital signal processing system, and the power amplifiers shall be monitored through software.
- G. The power amplifiers shall report alarms like power supply temperature, thermal level meters, fault reports and speaker line shorted or open reports.
- H. The monitoring station shall be rack mountable and shall display all systems alarms in an event log window.

2.8 RACKS, CABINETS AND ACCESSORIES

- A. General Description:
 - 1. The installer shall supply a system of vertical racks capable of supporting specified electronics.
 - 2. The cabinets shall be comprised of interchangeable modular components capable of being configured in a variety of heights either as a single unit or as a series of connected units.
 - 3. Side components shall offer ventilation. The bottom shall be open with closure panel available.
 - 4. Rack rail options shall include both punched and tapped (threaded) holes.
 - 5. Model options shall include those that are welded and shipped as an assembled unit or those that are shipped knocked down and assembled on site
- B. Standards:
 - 1. The system shall preferably comply with Underwriters Laboratories (U.L.) listing. Copy of the U.L. certificate of approval to be submitted upon request.
 - 2. The system shall comply with Electronic Industry Association (E.I.A.) specifications for rack mounting ANSI/EIA standard RS-310.
- C. Modular pre-engineering construction:
 - 1. All components within each rack cabinet shall be:

- 2. Of pre-engineered construction i.e: constructed from a series of independent components.
- 3. Available from a pre-defined set of manufacturer's component model numbers or as a single model number representing a complete cabinet.
- 4. In common production for at least two years prior to the date of submission.
- 5. Free from alterations to the installed cabinet or series of cabinets, will be accomplished without the need for either welding or carpentry work.
- 6. Capable of cables or conduits passing through the entire width of a series of connected vertical cabinets without obstruction.
- 7. Capable of supporting E.I.A. standard 19"(483mm) width rack mounted equipment.
- 8. Constructed of 14 and 18 gauge (.074" and .047") steel superstructure framework with external attachable side, top, rear, and bottom panels 20 gauge (.036") sides, 14 gauge (.074") base, 20 gauge (.036") tops, and 14/18 gauge (.074"/.047") combo for frames.
- 9. Constructed of 14 gauge (.074) steel inner and outer rack rails.
- 10. Supplied with a series of standard vented or solid blank panels which are determined by the installer and included to cover areas not filled in with specified equipment. These panels shall be measured in standard rack unit multiples and available with standard part numbers for future changes to the system.
- D. Optional accessories and mounting hardware:
 - 1. A full range of optional accessories are available including but not limited to: Caster kit, electrical outlet supply, anti-tip extension legs, shelf support brackets, stationary shelves, pullout shelves, rack slide kits, drawers, blowers and cooling fans, corner fillers and spacers.
 - 2. Mounting hardware for the specified electronics shall be available upon request. Panel bolts, washers and clips with captive nuts suitable for use with E.I.A. standard punched racks shall be included.
 - 3. Slide kits where appropriate (including drawers) shall be of ball bearing operation. Friction or roller type slides are not acceptable.
- E. Uninterrupted power supply:
 - 1. All racks shall include a UPS unit cable of handling the power requirements of that specific rack where they are installed.
 - 2. The UPS shall have remote monitoring capabilities through and Ethernet connection.

2.9 BASIS OF DESIGN

A. The Project Documents have been developed, in conjunction with the Owner, to establish a benchmark level of performance and reliability. The basis of design for the PA system is the QSC solution. Acceptable alternate product manufacturers are Biamp Vocia and Atlas. Deviations from the basis of design (including deviations for manufacturers stated herein as "acceptable" alternates) must be in accordance with the substitution requirements of Section 270010. Use of an alternate product, whether or not it is stated as "acceptable" herein, does not relieve the Installer of their responsibility to comply fully with the entirety of the Project Documents.

2.10 IDENTIFICATION AND LABELING TAGS

A. The PAS installer shall follow labeling materials indicated in specification section 270010.

PART 3 - EXECUTION

3.1 INSTALLATION PRACTICES

- A. The PAS installer shall follow all installation practices indicated in specification section 270010.
- B. Wiring color codes shall be strictly observed and terminations shall be uniform throughout the building.
- C. All wiring terminals, connectors, punch down blocks shall be clearly labeled and numbered. These designators shall be shown on the "as built" drawings. The labeling process shall be consistent with any owner standard or if non-existing, it shall comply with ANSI/TIA/EIA-606 C "Administration Standard for Telecommunications Infrastructure of Commercial Buildings".
- D. All major components installed in the equipment racks shall be equipped with engraved or photo laminated labels identifying area(s) served by that device. The labels shall correspond with designators on the "as built" drawings.
- E. Physical integrity of cables shall pass not only electronic testing but visual inspection as well by the Owner and/or the Engineer.
- F. Only a single point of ground, located at the amplifier cabinets shall be used.
- G. All wiring shall be separated as far as practical relative to signal levels (microphone level, speaker level and AC power). None of these different groups of cables may share a common raceway or wiring trough.
- H. All speaker lines shall be terminated in screw type terminal blocks located on DIM rails inside the equipment cabinets. All microphone cables shall be terminated on rack mounted 110 punchdown blocks, at least four (4) feet away from speaker line terminations.
- I. All connections to screw type terminals shall be made only by spade lugs, crimp fastened to wire.
- J. Splices within conduit runs, or cable trays shall not be permitted.
- K. Amplifier cabinets shall be properly grounded.
- L. All active equipment for the PA system shall be protected by power surge suppressors and backed up with UPS power.

3.2 PA SYSTEM INSTALLATION

- A. The Installer shall install and wire all speaker enclosures, speakers, baffles and microphone stations as shown on the drawings. Speaker enclosures shall be stuffed with 5/16" thick sound deadening acoustic batting with a density of 2 lb/cu.f t, and features an acoustic fiber board bottom to prevent "oil canning". For 12" speakers the enclosure shall have a 1.5" fiberglass liner.
- B. All ceiling mounted speakers shall be installed with a safety support to a solid building structure.

- C. All ceiling mounted speakers shall be provided with the corresponding supports to mount in dry wall ceiling or acoustical tile ceilings.
- D. The PAS installer shall make provisions for adding supports to the speaker's backboxes in case the ceiling structure can't support the weight of the speaker/backbox assembly.
- E. All output zones shall be included in the digital signal processing systems. The PAS installer shall program this system until the owner is satisfied with the sound output. All programming tools and software shall be delivered to the owner as part of the hand-over process. The final system configuration of the digital system processing system shall be documented and delivered to the owner as part of the as-built documentation.
- F. The Installer shall fabricate and install the amplifier racks, including all components. Spare equipment shall be installed in racks as shown on the drawings.

3.3 SERVICE SLACK

A. All PA system cable runs shall not contain service slack prior to the termination point at the head-end equipment side. Service slack at PA rooms shall consist of a 10 foot slack section located and placed neatly in the cable ladder above the equipment rack in an extended large diameter loops or in a loose figure 8 configurations.

3.4 CONDUIT INSTALLATION AND WIRING

- A. Minimum conduit size shall be 3/4 inch, except the small section of flex conduit linking the speaker enclosure to the ceiling mounted J-box above the speaker. This short section of flex conduit can be sized ½".
- B. All speaker and microphone wiring shall be run in conduit. Size of the conduit shall be in compliance to National Electrical Code (NEC) and local codes fill ratios.
- C. PA system installer shall provide all conduit, wiring and supports materials required by the system.
- D. Conduits shall be installed by the Installer for all "home run" wiring and at all areas.
- E. Minimum conduit size shall be 3/4 inch, except the small section of flex conduit linking the speaker enclosure to the ceiling mounted J-box above the speaker. This short section of flex conduit can be sized 1/2".
- F. All speaker and microphone wiring shall be run in conduit. Size of the conduit shall be in compliance to National Electrical Code (NEC) and local codes fill ratios.
- G. All conduit runs shall follow specifications in section 270528.
- H. The Installer shall install all cable trays and wiring as required for the installation of the audio racks.
- I. All speaker wires shall have and overall shield and the wire size shall guarantee a maximum of two 2% voltage drops to the farthest speaker in a zone. Minimum wire size shall be AWG-18 in all cases.

- J. All microphone audio and control lines wire shielding and sizing shall be in accordance to system vendor recommendations and standard distance limitations.
- K. All PA system cabling using UTP cable or fiber optics cables shall comply with section 271000 specifications for all requirements.

3.5 REQUEST OF IP ADDRESS

A. General: The PAS installer shall follow all requirements indicated in specification section 270010 for the request of IP addresses for devices part of the PAS.

3.6 SYSTEMS WARRANTY AND SERVICE

A. General: The PAS installer shall follow all warranty and service requirements indicated in specification section 270010.

3.7 ENGINEER'S FINAL ACCEPTANCE TEST

- A. General: The PAS installer shall follow all test requirements indicated in specification section 270010
- B. As part of the Engineer's final acceptance the following activities will be executed by the Engineer:
 - 1. Test all microphones in the system and all their features
 - 2. Test for audio at all speakers with a SPL meter
 - 3. Any other test the engineer deems necessary to establish the system is operating properly.

3.8 TEST EQUIPMENT REQUIRED

- A. Sound pressure level meter with the following characteristics:
 - 1. Applicable Standards: IEC 61672-1, 60651 and 60804 Type 2, ANSI S1.4 Type 2
 - 2. Accuracy: ±1.5dB (ref 94dB@1KHz)
 - 3. Resolution: 0.1dB
 - 4. Digital Display: 4 digital LCD
 - 5. Measurement Parameters: SPL, SPL MIN/MAX, SEL, and Leq
 - 6. Measurement Range: 30dB to 130dB
 - 7. Linearity Range: 100dB
 - 8. Measurement Frequency Range: 31.5Hz to 8KHz
 - 9. Frequency Weighting: A and C
 - 10. Response Impulse: Fast and Slow
 - 11. Microphone: 1/2 " Electret condenser microphone
 - 12. Sampling time: updated every 0.5s
 - 13. Bar graph: 4dB steps, 100dB range, 125ms update
- B. A pink noise audio source to be played in the system to check SPL.

3.9 TRAINING AND INSTRUCTION

- A. General: The PAS installer shall follow all training requirements indicated in specification section 270010.
- B. The PAS installer shall provide for Factory training for all hardware and/or software components. The installer shall provide for a week of training for three employees at the Manufacturer's facilities. The scope of the training shall include design, operation and maintenance of the system installed. The detailed schedule of the training shall be submitted by the installer no later than 10 days after a contract is signed.
- C. The training for this system shall include:
 - 1. User system operation training: Three sessions of two to three hours each, of user system operation on site to a maximum of fifteen attendants per session. Each session shall cover the same topics. One set per attendant of basic user operation material shall be delivered by the PAS installer.
 - 2. System administration training: Three sessions of at least four hours of system administration training on site to a maximum of five attendants per session. One set per attendant of System Administration material shall be delivered by the PAS installer.

3.10 SPARE PARTS AND TOOLS

- A. Prior to completion of this project the PAS installer shall provide spare parts for this system as referenced below. All spare parts provided for this project must be new hardware. Factory serviced or reconditions components shall not be acceptable. All equipment must be made available for inspection prior to delivery. Provide an inventory record of all spare parts to avoid any discrepancies. The delivery date shall be coordinated with the owner to ensure that secure storage of these parts can be provided upon receipt. The spare parts to be provided are:
 - 1. Paging stations: complete quantity of each type.
 - 2. Speakers: complete quantity of each type.
 - 3. List all other equipment.

3.11 AS-BUILT DOCUMENTATION AND CLOSE OUT INFORMATION

- A. General: The PAS installer shall follow all as built and close out information requirements indicated in specification section 270010
- B. As-built documentation shall include:
 - 1. Floor plans with all speakers, microphones, conduits and boxes shown and numbered as installed.
 - 2. All cable routings (trunk lines) and elevations of each TR or ER indicating outlet, tie, and riser cable terminations shall be required.
 - 3. All addendum information or project revisions resulting in drawing changes that occur during the construction period shall be documented and included in the as-built material.
 - 4. All rack elevations and mounting details.
 - 5. The PAS Installer shall provide a spreadsheet with the following information:
 - a. For speakers: speaker model, speaker number, zone, location and transformer tab used.
 - b. For microphones and sense microphones: microphone model, microphone number, zone, location and marking of the cables that the microphone uses.
- C. The close out information shall also include:
 - 1. Submission and Approval of test reports.

END OF SECTION 275113

SECTION 27 5119 SOUND MASKING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Addressable sound-masking systems.
 - 2. Direct-field sound-masking systems.
 - 3. Centralized sound-masking systems.

1.3 **DEFINITIONS**

- A. Authorized Dealer: Company chosen to provide all sound-masking system products described in Part 2. This dealer must be an authorized dealer of manufacturer's products.
- B. Contractor: Company chosen to install the sound-masking system.
- C. Loudspeaker or Speaker: Terms used interchangeably to indicate a device in the soundmasking system that emits masking sound and voice paging or music.
- D. Manufacturer: Company that produces the sound-masking system products.
- E. Project Manager: Architect, Owner's representative, general contractor, or other project manager in charge of construction and Project site.
- F. Sound-Masking System: Electronic equipment and loudspeakers used to generate, distribute, and control masking sound throughout a treated area.
- G. Sound-Masking System Designer: Person or team responsible for design of the sound-masking system.
- H. Spatial Uniformity: A condition where the sound-pressure levels throughout a defined space do not vary significantly from the arithmetic mean sound-pressure level.
- I. Spectral Uniformity: A condition where the sound pressure in each one-third-octave band does not vary significantly from the specified one-third-octave sound-pressure level.
- J. SPL: Sound-pressure level in dB re 0.00002 Pa (0.0002 microbar).
- K. Temporal Uniformity: At a given position, a condition where the average sound-pressure level measured over a short time interval does not differ significantly from the average sound-pressure level measured over a long time interval.

L. Zone: One or more networked loudspeaker controllers assigned by privacy manager software to operate as a named group.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for loudspeakers.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 3. Nationally recognized testing laboratory listing data for plenum-mounted equipment.
- B. Shop Drawings: For sound-masking systems.
 - 1. Include plans, elevations, sections, and mounting details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Field quality-control reports.
 - 1. Test and system calibration instrument list and instrument calibration documentation.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For sound-masking equipment and components to include in emergency, operation, and maintenance manuals.
- B. Overall System Operation Manual: For use by Owner's maintenance personnel.
- C. Software and Firmware Operational Documentation:
 - 1. Inventory of system components, with model and serial numbers for each.
 - 2. Software operating and upgrade manuals.
 - 3. Program Software and System Settings Backup: On digital media complete with data files.
 - 4. Device address list.
 - 5. Printout of software application and graphic screens.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

- 1. Sound-Masking Loudspeaker Assemblies: One for every 10 of each type of loudspeaker assembly, but no fewer than one.
- 2. Fuses: Ten for each type used, but no fewer than one.

1.8 QUALITY ASSURANCE

- A. Sound-Masking System Designer shall be: Authorized Dealer Trained and Certified by the Manufacturer
- B. Sound-Masking System Commissioning shall be performed by: Authorized Dealer Trained and Certified by the Manufacturer
- C. Contractor Qualifications: An entity experienced in the provision of low-voltage electronic systems similar in complexity to those required for this Project, and meets the following:
 - 1. Contractor's primary business is the provision, fabrication, and installation of integrated audio and video systems including distributed sound systems, structured cabling, and/or related systems in the commercial environment.
 - 2. Contractor is an authorized dealer for the major product components furnished.
 - 3. Contractor is an authorized dealer for the major product components and is certified by the manufacturer to perform their installation and setup.
 - 4. Contractor has a verifiable history of successful installations of at least three projects of similar scope and size.
 - 5. Contractor has all applicable business and regulatory licenses and certifications.
 - 6. Contractor has verifiable financial capability to satisfy Project and bonding requirements.
 - 7. When so directed by the Sound-Masking System Designer, Contractor must have obtained the necessary personnel expertise and test measurement equipment outlined herein to configure, test, and calibrate the sound-masking system.
- D. Project Management: Contractor shall assign a qualified person to manage the installation and maintain the same person in charge of work throughout installation.
- E. Equipment and accessories, including such things as cabling where applicable, shall be supplied by a dealer authorized by the equipment manufacturer.
- F. The Installer shall possess a State of Florida Low Voltage License.
- G. The Installer shall maintain a permanent office within 150 miles of the project site.
- H. A current certificate of insurance meeting the Owner minimum insurance requirements.
- I. Comply with NFPA 70.
- J. Comply with UL 813.

1.9 COORDINATION

- A. Coordinate quantity and arrangement of loudspeaker assemblies with ceiling space configuration and with components occupying ceiling space, including structural members, pipes, air-distribution components, raceways, cable trays, luminaires, and other items.
- B. Sequencing and Scheduling:

- 1. Coordinate work with Project Manager and other trades to facilitate construction and prevent conflicts.
- 2. Afford other trades reasonable opportunity for installation of work and for the storage of materials.
- 3. Staff the job to keep pace with the other trades, otherwise, Project Manager will require an increase in force or overtime work without additional expenses to Owner.
- 4. Abide by the decision of Project Manager in case of conflict or interference by other trades.

1.10 WARRANTY

- A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace sound-masking system components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 12 months from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOUND-MASKING SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Compliance Standard: Fabricate and label electronic components to comply with UL 60065 or UL 1419.
- C. Wire, cable, devices, and assemblies installed in air-handling spaces shall be plenum rated, complying with NFPA 70 requirements for rate of heat-release and smoke-release characteristics. Tests for these requirements shall be in accordance with UL 2043.

2.2 PERFORMANCE REQUIREMENTS

- A. Functional Requirements for Sound-Masking Systems:
 - 1. Distribute sound masking for first floor patient advocacy department and first floor PAT registration department.
 - 2. All active electronic components shall be conveniently accessible for service.
 - 3. All systems components shall be supplied from a single manufacturer.
- B. Comply with UL 813.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Compliance Standard: Fabricate and label electronic components to comply with UL 60065 or UL 1419.
- E. Wire, cable, devices, and assemblies installed in air-handling spaces shall be plenum rated, complying with NFPA 70 requirements for rate of heat-release and smoke-release characteristics. Tests for these requirements shall be in accordance with UL 2043.

2.1 DIRECT-FIELD SOUND-MASKING SYSTEMS

- A. Description: Direct-field sound-masking systems utilize a networkable central control module(s), available in single-, three-, or six-zone configurations, that acts as the masking signal processor, audio input source, and amplifier. Sound-masking emitters (loudspeakers) may be selected by type for each separate zone to provide sound-masking only (Type 1). The downward firing sound-masking emitters are daisy-chained from the control module via 8-conductor category cable, resulting in radiated sound-masking coverage directly into the listener's occupied space. This creates a preconfigured sound-masking spectrum free of acoustic transmission loss presented by building materials. Direct-field masking systems are capable of generating, amplifying, and distributing a minimum of four noncorrelated sound-masking signals on adjacent loudspeakers, alleviating the destructive acoustic interference found in single-channel systems. Adjacent loudspeakers should not reproduce coherent sound-masking signals in order to maximize occupant sound uniformity. Direct-field sound-masking systems are capable of providing a separate controllable volume zone for each unique architectural functional space, as well as each separate emitter mounting (ceiling) height.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide Cambridge Sound Management; QtPro or comparable product by one of the following:
 - 1. Lencore.
 - 2. Moeller, K. R. Associates Ltd.
- C. General:
 - 1. Product requirements include all masking, signal generation, signal processing, amplification, and loudspeakers with associated wiring, software, and controls.
 - 2. Only complete, integrated sound-masking systems from a sole manufacturer shall be acceptable.
 - 3. Sound-masking system shall be capable of multiple zones as depicted on Drawings in order to adjust for unique architectural spaces and facility uses.
 - 4. Sound-masking system shall be capable of automatically scheduling system parameter adjustments, including initial acclimatization, on a per-zone basis.
 - 5. Means of control may be facilitated through any combination of front-panel hardware interface, wall-mounted controls, and/or web browser-based software interface.
 - 6. Sound-masking system shall be capable of generating, amplifying, and distributing a minimum of four non-correlated sound-masking signals on adjacent loudspeakers. Adjacent loudspeaker devices may not reproduce coherent sound masking signals.
 - 7. Sound-masking system shall be capable of accepting, at a minimum, one external linelevel audio source from ancillary audio equipment with control on a per-zone basis.
 - 8. Sound-masking system zones shall be determined by the functional requirements of each area(s) with separate independent level control for each zone as indicated by Project documents.
 - 9. A separate level control zone shall be required in instances where a change in loudspeaker mounting/ceiling height varies by more than 6 inches (152 mm) throughout a functional space.
- D. Loudspeakers:
 - 1. Loudspeakers shall be direct-field, radiating directly into the occupied space. Plenumbased loudspeaker systems are not acceptable under this Specification.
 - 2. Direct-field loudspeaker drivers shall be less than 4 inches (104 mm) in diameter and be capable of mounting directly into acoustic ceiling tile materials, surface mounted, pendant mounted, structural beam mounted, or hard surface ceiling mounted utilizing optional

manufacturer-supplied accessories. Provide seismic-rated mounting where required by jurisdiction.

- 3. Place loudspeakers where indicated on Drawings. Space evenly as recommended by the product manufacturer based on site conditions and ceiling heights and below finished ceiling obstructions to meet the performance requirements stated in this Specification.
- 4. Loudspeakers as driven by control processor/module shall be capable of producing minimum sound-pressure levels and frequency spectrum as required in Part 3 of this Specification and as measured at an above finished floor height of 4 ft. (1.2 m) regardless of ceiling type, height, or presence.
- 5. Loudspeakers and accessories mounted in air-handling spaces shall be UL 2043 compliant.
- 6. Active (self-powered) direct-field loudspeakers and power supplies are acceptable under this Specification only when UL 2043 listed for use in air-handling spaces.
- 7. DC power for active loudspeakers must be combined with masking and audio input signal in a single, multi-conductor, low-voltage cable meeting NEC Class 2 requirements for low-voltage distribution and suitable for use in plenum spaces.
- 8. Active (self-powered) direct-field loudspeakers shall be used in locations where paging and background music are required. Remotely powered (passive) loudspeakers shall not be used for paging signal or music reproduction.
- 9. 70-volt / 25 volt or other high-voltage distribution is not allowed under this Specification.
- E. Control Processor Modules:
 - 1. Provide DSP-based masking sound generation with a minimum of four uncorrelated masking signal outputs per zone.
 - 2. Provide a factory default sound masking spectrum as defined in Table 1 in Part 3 of this Specification.
 - 3. Multi-zone processing shall provide adjustment of the masking level on a per-zone basis with adjustment in .5 dB increments.
 - 4. Multi-zone processing shall provide per-zone scheduling function via internal clock source and/or network NTP server, capable of adjusting the masking signal levels. Scheduling shall, at a minimum adjust for separate weekday and weekend level settings.
 - 5. Multi-zone processing shall provide an automatic, incremental level adjustment feature, allowing a gradual, one-time change of masking levels to commence upon completion of system commissioning, acclimating occupants to a newly sound-masked environment (initial acclimatization).
 - 6. Multi-zone control processor shall be capable of TCP/IP network connectivity via DHCP or Static IP address.
 - 7. Each masking zone, when multiple zones are required, shall be separately capable of one-third-octave equalization adjustment of the sound-masking spectrum as defined in Table 1 in Part 3 of this Specification. Equalization shall be set at the factory. No field equalization shall be necessary under this Specification.
 - 8. Control processor shall have at least one line-level audio input accepting a nominal signal level of +4dBu. A separate one-octave band equalizer, independent from the sound-masking equalizer, shall be provided for adjustment of the audio input.
 - 9. Control processor shall have the capability to mute or otherwise disable the sound masking signal and minimal one line-level audio input(s) using a dry contact closure from a third-party source.
 - 10. Fault reporting of trouble conditions to cabling and ancillary devices shall be incorporated at the control processor level.
 - 11. Control processor shall feature a nonvolatile memory, capable of storing all system settings in the case of power disconnect.
 - 12. System shall include a UL/CUL/CE -listed 120-240VAC 50/60Hz power supply. Remote power supplies when mounted in air-handling spaces shall be plenum-rated pursuant to local codes and jurisdictions.

- F. Software and Control:
 - 1. Multi-zone sound-masking system shall be capable of software control via a TCP/IP local area network connection to Owner's local area network (LAN Infrastructure).
 - 2. Coordinate connection to local area network with Owner's network administrator to include IP Addressing, MAC address, and switch port assignments.
 - a. The software interface may consist of one or more of the following types:
 - 1) Client-Based Control: Microsoft Windows 7/10.
 - 2) Web: Internal web server using browser client
 - 3) Mobile: Internal web server using browser client or software applications for Apple IOS/ Android OS devices.
 - 3. Software control of multi-zone sound masking shall include password-protected adjustment and configuration of the following minimum features to include:
 - a. Sound-masking levels on a per-zone basis.
 - b. Audio input levels on a per-zone basis.
 - c. Equalization adjustment on a per-zone basis.
 - d. Zone naming on a per zone-basis.
 - e. Time of day scheduling on a per-zone basis.
 - f. Network / clock management.
 - g. Three-step incremental level adjustment on a per-zone basis.
 - h. Error notification / monitoring.
 - 4. A hardware interface will be capable of basic level adjustment on a per-zone basis using either or both of the following methods:
 - a. Wall Level Control: A single gang flush mounted device capable of adjusting the overall sound level up to eight loudspeakers. Locations of wall controls shall be indicated on Drawings.
 - b. Control Processor Front-Panel Menu: A hardware interface that allows, at a minimum, operation of both sound-masking and audio input levels on a per-zone basis.
 - 5. Control via a third-party appliance/software shall allow adjustment of the sound-masking and audio input levels on a per-zone basis.
 - a. A third-party API shall be published by the sound-masking product manufacturer to allow programming by building-wide / room-control system providers.
 - b. Third-party control shall be via either wired Ethernet or contact closure control.
- G. Cable Assemblies:
 - 1. All cable assemblies shall consist of the proper number of conductors, wire gauge, and type, as approved by the system manufacturer based on the system design.
 - 2. Cabling flammability rating shall meet the installation conditions as required by NFPA/NEC/CSA or local codes/ jurisdiction as follows:
 - a. Type CM General Purpose for Commercial Installation. Meeting UL 1581 requirements for smoke and flammability testing.
 - b. Type CMR/FT4 Commercial Installation for vertical risers. Meeting UL 1666 requirements for smoke and flammability testing.

- c. Type CMP/FT6 Commercial Installation for plenum airspaces. Meeting UL 910 requirements for smoke and flammability testing.
- 3. Terminations shall be completed utilizing the appropriate connector type, method, and tooling as recommended by product manufacturer.
 - a. Field terminations shall be permitted in cases only where approved by product manufacturer.
- 4. Ethernet cabling shall be a single-jacket UTP Category 5e, Category 6, or Category 7.
- 5. All Emitter cabling shall be a single-jacket UTP Category 3, Category 5e, Category 6, or Category 7 cable with 8-conductor TIA/EIA568B modular plug connectors.
- 6. Each Ethernet cable shall be verified by the Installing Contractor to 10/100 MB/sec standards.
- 7. Factory-supplied UTP Category interconnect cables will be utilized whenever feasible based on available cable length.

H. Labels:

- 1. Except where otherwise specified, label each item of control equipment as indicated on Drawings.
- 2. Identify all wires and cables at every connection point to controllers with reference number keyed to the as-built wiring diagrams.
- 3. Room numbers appear on the Contract Documents for reference only. All labels shall reflect Owner's final room designations.
- 4. Cable Markers:
 - a. High-grade PVC clip-on or permanent-type cable markers with permanent markings, or printed vinyl tape protected by clear shrink tubing or adhesive wrap.
- I. Safety Listings:
 - 1. General:
 - a. Products and system shall comply with all applicable local, regional, and national safety codes.
 - 2. Electrical Safety:
 - a. All electronics shall be UL Listed or listed by an equivalent body such as Intertek ETL. Outside the USA, the electronics shall be certified by an equivalent certification body to meet local and/or national safety standards.
 - 3. Seismic Safety:
 - a. Loudspeaker seismic support must be provided by manufacturer-certified electronic input cable supported by a copy of manufacturer's test report. Alternate seismic support system(s) must be approved by authorities having jurisdiction and based on local code requirements.
 - 4. Fire Safety:

- a. Control processor shall have the capability to mute or otherwise disable the soundmasking signal and any line-level audio input(s) using a dry contact closure from a third-party source such as a fire alarm panel.
- b. Sound-masking system shall not be a primary means of emergency voice evacuation or ECS. For this reason, UL 2572 compliance is not required under this Specification.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Prior to installation, ensure the site is suitable for system installation.
- B. Verify that all locations where system components are to be installed are free of conflicts with other trades prior to installation.
- C. Verify that site building conditions match the system design plans including ceiling finishes, wall locations, and obstructions. Immediately notify the Project Manager of any discrepancies prior to the commencement of work.
- D. Notify the Project Manager of any defects in work by other trades affecting system installation, operation, or performance.
- E. Ensure that system power requirements, network connectivity, and any other third-party infrastructure requirements for the system have been provided and installed prior to installation.

3.2 DELIVERY, STORAGE, AND HANDLING

- A. Protect all system components from moisture, dust, and damage during shipping, storage and handling.
- B. Deliver in manufacturer's original unopened and undamaged packages with manufacturer's labels legible and intact.
- C. Inspect all system components upon receipt and upon unpacking.

3.3 INSTALLATION

A. General

- 1. Comply with all applicable electrical and other safety codes.
- 2. Install sound-masking system in compliance with manufacturer's written instructions and published documentation.
- 3. All equipment shall be installed by competent workers at locations indicated on Drawings in strict accordance with approved Shop Drawings. Record any and all necessary changes to the system design in cases where different from the submittal documents.
- 4. All equipment shall be firmly held in place including loudspeakers, enclosures, amplifiers, processors, cables, and so on. Fastenings and supports shall be adequate to support their loads with a safety factor of at least six unless otherwise stated.

- 5. All system components shall be mounted in a level and plumb fashion utilizing the dimensions indicated on Drawings.
- 6. User controllable devices shall be mounted at a location and height that allow for normal adjustment and operation.
- 7. Electronics shall be conveniently accessible for service.
- 8. Above-ceiling equipment shall be UL 2043 rated for air-handling environments.
- B. Loudspeakers:
 - 1. Locate loudspeaker assemblies as indicated on Drawings and as required to meet the spatial uniformity requirements of this Specification.
 - 2. Ensure loudspeaker coverage pattern is not obstructed by building systems or structures that may impede performance of the sound-masking system.
 - 3. When mounted in other substrates, ceiling types, and or building structures, loudspeakers shall be installed using manufacturer-supplied accessories. Mount loudspeaker assemblies to structure in an approved method as required by local codes and jurisdiction, and indicated by Project submittals.
 - 4. For in-plenum systems, boot or otherwise acoustically treat all cold-air return plenum openings in the ceiling.
 - 5. To the greatest extent possible, maintain equal loudspeaker spacing.
 - 6. For Type 2 loudspeaker usage, ensure raised access floor openings are sealed.
 - 7. Verify loudspeaker locations are, a minimum of 4 ft. (1.2 m) away from open air vents for both Type 1 and Type 2 loudspeakers.
- C. Cabling:
 - 1. All cable installation shall be done in a professional, workmanlike manner with adequate service loops where applicable. Dress cabling in a neat and consistent fashion using appropriate methods and materials.
 - 2. Test all field-fabricated and manufacturer-supplied cables, before installation, for open circuits, shorts, crossed pairs, reversed pairs, split pairs, and proper pin-out.
 - 3. Refer to manufacturer's written instructions as to maximum cabling distances and types to support control processor unit(s), controls, and loudspeakers. Never exceed manufacturer's cable distance limitations and quantity of devices per cable run.
 - 4. Cabling pathways shall be configured to prevent conflict with other building systems. Care should be taken to minimize and eliminate all RFI and EMI interference sources.
 - 5. Maintain appropriate separation between dissimilar signal types, voltages, and electrical devices.
 - 6. Cabling to be installed/supported in a manner and frequency utilizing approved methods and materials as required by the local authorities having jurisdiction.
 - 7. Cabling shall be installed in metallic rigid or flex conduit only as indicated on Drawings/Specification and using manufacturer-approved accessories.
 - 8. All cabling shall be supported from structure. Cabling shall not contact ceiling tiles or inhibit their removal for access to the plenum.

3.4 SITE QUALITY CONTROL

- A. Ensure that loudspeaker spacing is correct, and consistent, and follows design guidelines set forth by the product manufacturer.
- B. Securely terminate all cables.

3.5 SYSTEM STARTUP

- A. Coordinate with building network administrator for an Ethernet connection to building LAN where required.
- B. Perform the entire product manufacturer's recommended testing and startup procedure as outlined in the manufacturer's product manual(s).
- C. Ensure functional operation of all ancillary devices to include front-panel controls, audio inputs, contact closures, wall controls, software control, and third-party controllers. Test each setting and confirm expected results from actions taken. Correct all deficiencies in operation.
- D. Perform system startup at a time when each zone/space is completely vacant and free of any noise contamination.

3.6 SYSTEM TESTS AND ADJUSTMENTS

- A. Qualifications of Testing Party:
 - 1. Testing, calibration, and setup shall be performed by a qualified manufacturer's employee or an authorized dealer or consultant who has been trained by the manufacturer.
- B. Prior to Test and Adjustment: Ensure the site conditions are suitable for adjustment of the sound-masking system. Adjustment can only be made when the following site conditions exist:
 - 1. All ceiling assemblies are currently installed and completed.
 - 2. All interior furnishings are assembled and in place.
 - 3. Mechanical systems have been previously optimized to final operational conditions and are active in areas served by sound-masking signals.
 - 4. No occupants are present at the time of adjustment.
 - 5. External noise sources (that is, construction activities) are not present during testing.
 - 6. Final testing shall be scheduled at least 30 days in advance of Owner occupancy.
 - a. Notify the party listed under Quality Assurance Article of the testing and adjustment schedule.
- C. Initial Test and Adjustments: Perform and record results of the following tests:
 - 1. Loudspeaker Operation: Near field output of each loudspeaker shall match the zone average within plus or minus 2.0 dB. Listen directly below each installed Loudspeaker to confirm it is operating.
 - 2. For any loudspeakers found to be inoperative, or possibly operating at an incorrect level, use a calibrated sound-level meter set to A-weighting and slow response to check the output. Place microphone directly below and equal distance from each loudspeaker. Measure the variation between a minimum of three adjacent loudspeakers of the same zone and sound-level setting.
 - 3. Replace any defective loudspeakers or cabling, or otherwise correct cause for any loudspeakers found to be operating outside the range stated.
 - 4. Buzzes, Rattles, and Distortion: With system operating at maximum level, listen for any buzzes, rattles, and objectionable distortion in all areas covered. Correct all causes of these defects.
- D. Final Test and Adjustment: Perform and record the results of the following tests:

- 1. Control Settings: Adjust all masking spectrum levels and audio level controls for initial operation using manufacturer's recommended procedures. Document setting for each user control.
- 2. Adjustment of Audio Input Levels: Adjust background music/paging levels for clarity above ambient noises with a minimum signal to noise ratio of 10 dBA above ambient sound levels. Adjust frequency spectrum of each input as necessary to achieve accurate reproduction of the intended signal source.
- 3. Adjustment of Sound Masking Levels: With the masking system active, measure the Aweighted sound-pressure level of each zone independently. Use an ANSI S1.4 approved and calibrated Type 1 or Type 2 sound-level meter and/or calibrated real time acoustic analyzer with 1one-third octave filters per ANSI S1.11. Perform all SPL measurements at a typical seated height of 4 ft. (1.2 m) AFF. Adjust the sound masking frequency spectrum in each zone to correspond with the A-weighted average level and frequency levels (non-weighted) shown in Table 1. Document, at a minimum, one measurement per 1000 sq. ft. (92.9 sq. m) in open offices, one measurement in 50 percent of private offices, and one measurement in 50 percent of all other spaces where sound masking is present. All documented measurements shall meet the maximum level variation column criteria of Table 1. Correct any sound-masking system deficiencies such as loudspeaker placement or loudspeaker tap settings to meet these performance criteria.

Frequency	Open Office	Private Office	Corridor / Conference Room	Max Variation
125 Hz	45 dB	40.5 dB	42.5 dB	+/- 5 dB
160 Hz	45 dB	40.5 dB	42.5 dB	+/- 4 dB
200 Hz	45 dB	40.5 dB	42.5 dB	+/- 3 dB
250 Hz	44 dB	39.5 dB	41.5 dB	+/- 2 dB
315 Hz	43 dB	38.5 dB	40.5 dB	+/- 2 dB
400 Hz	41 dB	36.5 dB	38.5 dB	+/- 2dB
500 Hz	40 dB	35.5 dB	37.5 dB	+/- 2dB
630 Hz	39 dB	34.5 dB	36.5 dB	+/- 1.5dB
800 Hz	37 dB	32.5 dB	34.5 dB	+/- 1.5dB
1000 Hz	36 dB	31.5 dB	33.5 dB	+/- 1.5dB
1250 Hz	35 dB	30.5 dB	32.5 dB	+/- 1.5dB
1600 Hz	33 dB	28.5 dB	30.5 dB	+/- 1.5dB
2000 Hz	32 dB	27.5 dB	29.5 dB	+/- 1.5dB

4. Table 1:

- 5. Configure time of day sound-masking level adjustment following the final adjustment of sound-masking levels. Coordinate with Owner to determine activity times and levels of occupancy. Adjust the sound-masking system based on the target Average A-Weighted Sound-Pressure Level in Table 1 as the final sound-masking levels used for high activity/occupancy times. Adjust the sound-masking system based on the targeted Average A-Weighted Sound-Pressure Level in Table 1 as the final sound-masking system based on the targeted Average A-Weighted Sound-Pressure Level in Table 1 with adjustment minus 3 to minus 9 dBA lower at times of inactivity/lower occupancy per product manufacturer's written instructions.
- 6. When integrating the sound-masking system in a space previously occupied by workers, configure the incremental level adjustment feature of the control processor. Following the initial adjustment of sound-masking levels, adjust each zone's initial sound-masking level to a level 1.5 dBA above the average ambient noise level of the space. Engage the incremental level adjustment feature to automatically increase the sound-masking level until reaching the Average A-Weighted Sound-Pressure Level shown in Table 1 for each type of space listed. Use a minimum timeframe of five days for the incremental level adjustment to reach the final target levels.
- 7. Provide a final testing report that states that the performance requirements of the soundmasking system have been met.
- E. Automatic Real-Time Masking Level Adjustment: Automatic adjustment of masking level based on ambient noise conditions shall not be permitted under this Specification. Only scheduled adjustment of sound masking levels may occur at times when each zone is vacant of occupants.
- F. Sound-Masking Equalization: On-site sound-masking equalization shall be performed by those qualified personnel specified in Quality Assurance Article to meet the values specified in Table 1.
- G. Proof of Performance Testing: demonstrate to Owner's Representative that the system is fully operable and installed in compliance with the terms of the performance specifications hereunder.
 - 1. Test the system to demonstrate that the design goal of privacy index (PI) of 80 percent (normal privacy) or better is met between representative workstations separated by partitions of 66 inches (1676 mm) or greater height. For this test, select adjacent workstation pairs without direct line of sight or significant sound reflecting ceiling or wall elements between, and with a ceiling material rated at NRC of 0.85 or higher. Tests shall be in accordance with ASTM E1130 except that the octave band calculation method of ANSI S 3.5 may be used. Lower levels of PI are acceptable only if the ceiling or partition requirements described herein are not met. Document the results of this test.
 - 2. Test the system in each open plan area zone served to demonstrate that the design goal for spatial uniformity is met. Tests shall be carried out per ASTM E1573 as measured in the 2,000 Hz octave band. At each location, the average sound-pressure levels shall be measured over an interval of at least 4 seconds at four positions at 90 degree intervals around a circle of 1 ft. (0.3 m) radius centered on the location. The arithmetic mean sound pressure level shall be calculated from the four measured values. For at least 75 percent of the test locations, the arithmetic mean sound-pressure level in the 2,000 Hz octave band shall not vary by more than plus or minus 2 dB from the average of the arithmetic mean sound-pressure levels measured at all locations. Document the results of this test.
 - 3. Test the system to demonstrate that the speech privacy class (SPC) is at least 75 (standard speech privacy) between representative private (enclosed) offices served by the system. For this test, select adjacent offices with closed doors free of air gaps. Tests shall be in accordance with ASTM E2638-10. Test 10 percent of all similar-sized offices

and meeting spaces utilizing the same basic construction methods. Lower levels of SPC are acceptable if the common walls between the offices are composed of assemblies <=STC 40 and that do not extend to the deck above, -or- in cases where the common wall <=STC 40 does not extend to the deck, and the ceiling attenuation class of the ceiling material is less than 45 (<=CAC 45). If the SPC achieved is lower than 75 due to architectural factors, bring this to the attention of Owner or General Contractor. Document the results of this test.

4. The sound-masking contractor will make all necessary modifications to the system design, integration, and/or settings, as specified by the System Designer, to achieve the performance testing goals contained herein at no additional expense to Owner.

3.7 CLEANING AND WASTE MANAGEMENT

- A. Remove empty packaging and other material waste.
- B. Clean all debris created by installation of components.
- C. Clean system components where required.

3.8 FINAL CLOSEOUT AND AS-BUILT DOCUMENTATION

- A. Contractor shall document, prepare and submit all final control processor settings, loudspeaker zone maps, loudspeaker tap settings, one-line diagrams, operational instruction, and testing results in PDF format. Submit three copies to the System Designer, Project Manager and, if required, Owner's representative for final review and acceptance.
- B. Indicate the location of each sound-pressure level measurement, PI measurement, and spatial uniformity measurement referenced within the final documents on the zone map.
- C. In cases where the sound-masking system utilizes client control software for adjustment and operation, provide a copy on media with each documentation set utilizing the same software version as currently installed and operating.
- D. With 30-day advance notice, train Owner's designated representative on sound-masking system maintenance and proper operation.
 - 1. Provide user instruction on operation.
 - 2. Discuss potential for mis-adjustment of sound-masking levels and deterioration of both comfort / speech privacy performance.
 - 3. Demonstrate all software features, controls, and configuration.

3.9 SERVICE AGREEMENT

- A. At Owner's request, provide an annual service and maintenance contract to commence after the one-year warranty period has expired.
- B. Services to include two semi-annual visits to the site for routine adjustment and maintenance of all equipment.

3.10 TRAINING

- A. General: The installer shall follow all training requirements indicated in specification section 270010.
- B. The training for this system shall include:
 - 1. User system operation training: Three (3) sessions of three (2) hours each, of user system operation on site to a maximum of fifteen attendants per session. Each session shall cover the same topics. One set per attendant of basic user operation material shall be delivered by the PAS installer.
 - 2. System administration training: Three (3) sessions of at least four (4) hours of system administration training on site to a maximum of five attendants per session. One set per attendant of System Administration material shall be delivered by the PAS installer.
- C. AV Recordings of all training shall be provided on USB drives.

END OF SECTION 275119

SECTION 27 5223 NURSE CALL SYSTEM

PART1- GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work specified of this section.

1.2 DESCRIPTION

- A. General: Provide, complete with all accessories, a VoIP-based audio visual nurse/patient communicating and signaling system. All system components excluding wiring shall be a product of a single manufacturer. System shall be Rauland-Borg Responder 5, no substitutions or alternates shall be permitted.
- B. Standards: The system shall be listed by Underwriters Laboratories as conforming to latest the edition of the UL Standard 1069.
- C. Material Selection Basis: Catalog and model numbers are intended to indicate type and quality of design and material as well as exact operating features required.
- D. Complete System: All items of equipment including conductors shall be provided to operate as a complete system.
- E. Additional Components: All equipment necessary for proper operation of the system shall be deemed part of this specification. Any equipment, material, or other item not specifically identified but required for operation as described shall be provided. Quality of unspecified items shall be equal to similar specified items.
- F. Provisions: The system shall be designed primarily as a "floor" or "area" system. Provisions shall be built-in to permit the control of other floors or areas from one central point.
- G. Components: The system shall consist of control equipment, nurse call master stations, single patient stations, multi-sectional dome lamps, patient control units (pillow speakers), call cords, toilet stations, shower stations, duty stations, staff stations, code blue stations, zone lamps, zone lamp modules, power supplies, coupling units and installation materials such as wire, cable and terminal blocks, including all interconnect wiring to owner provided televisions to provide a complete operating system.
- H. Interface: It shall be possible to interface the system with other auxiliary systems such as voice paging and patient entertainment. For television installations where the nurse call will provide channel and volume control, the nurse call vendor shall be responsible for all wiring interconnects and terminations, including those from the wall plate to the television unit.
- I. Central Control: Floor or area systems shall be equipped with the necessary hardware and software required to permit optional centralized operation from a central control point. The central control point shall be equipped with the program necessary to operate and control other floors or areas in a given system as shown on the drawings. Additionally, the system shall allow for zone coverage of floors between multiple master station locations and shall be capable of "swinging' calls from one station to another.

1.3 SUBMITTALS

- A. Shop Drawings: Shop drawings shall be complete showing all wiring diagrams and point to point connections required for this project. The point to point connections shall be indicated on drawings showing routing of raceways, connections, components, and conductor quantities and types. The Contractor shall apply his company name, address, telephone number, etc. Computer CAD drawings are required.
- B. Product Data: Submit manufacturer's standard catalog data on all components and subsystems. Product data shall be submitted showing manufacturer's written recommendations for storage and protection, and installation instructions. Manufacturer's product data shall be submitted for all system equipment including;
 - 1. Application Information
 - 2. Dimensions
 - 3. Listing Agency File
 - 4. Wiring Diagrams
 - 5. Installation Information
- C. Annual Inspections: The Contractor shall provide hourly Service Rates and Semi-Annual inspection prices, performed by a factory trained and authorized personnel, for this installation with the submittal. Proof of training and authorization of the servicing personnel shall be included in the submittal. The hourly service rates shall be guaranteed for a one-year period unless otherwise specified.
- D. Close-out Submittals: Two (2) copies of the following Manual shall be delivered to the Building Owner's representative at the time of system acceptance. The close out submittals shall include:
 - 1. Operating manuals covering the installed Nurse Call System.
 - 2. Point to Point diagrams of the entire Nurse Call System as installed. This shall include all connected devices, master stations, and annunciators. All drawings shall be provided in CAD and supplied in standard .dxf format. Vellum plots of each sheet shall also be provided. A system-generated point to point diagram is required to ensure accuracy.
 - 3. The application program listing for the system as installed at the time of acceptance by the building owner and/or Local AHJ (Disk and Hard copy printout).
 - 4. Name, address and telephone of the authorized factory representative.
 - 5. All drawings must reflect device address and programmed characteristics unless device addressing is electronically generated, and graphically printed.
 - 6. Certificate of Training.

1.4 MICROPROCESSOR BASED

- A. Patient Stations: The system shall be provided with microcomputer controlled patient stations.
- B. Programming: The system shall employ stored program software techniques.

C. Component Design: For ease of installation and maintenance, system components shall be of modular and plug-in type design.

1.5 WARRANTY

- A. The System Supplier shall provide a warranty on the system which shall include all necessary labor and equipment to maintain the system(s) in full operation for a period of one year from the date of acceptance.
- B. In addition, the equipment (parts) warranty for all core system components including control / switching equipment, power supplies, patient stations, sub-stations, and nurse consoles shall extend to a total of at least five (5) years. Warranty for ancillary devices such as pillow speakers and call cords shall extend to a total of at least two (2) years.
- C. Manufacturer shall provide, free of charge, product firmware/software upgrades throughout the warranty period for any product feature enhancements.
- D. After the acceptance of the system(s) service shall be provided on the following basis:

Emergency Service -	Provided 24 hours a day. When a total or catastrophic failure of equipment is reported to contractor, within 2 hours of notification, a service person will be on site. (An example of a catastrophic failure would be a hub failure or a nurse console failure.)
Routine Service -	Provided within 4 business hours (9 a.m. to 5 p.m., Monday through Friday, excluding holidays) of notification. When a minor failure of equipment is reported to contractor, a service person will be on site within 24 hours of notification. (An example of a minor failure includes peripheral equipment such as control stations, entertainment speakers, corridor lights, pull-cord stations, etc. which normally affect only one patient or patient room.)

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The products specified shall be new and of the standard manufacture of a single manufacturer. Equipment system shall be manufactured by Rauland-Borg Corporation, Mount Prospect, IL to match existing installation.

2.2 NETWORK WIRING

- A. All Nurse Call Network wiring shall be only CAT 5E or CAT 6. Plenum wire shall be used in open areas and standard CAT 5E or CAT 6 within conduit. System shall be capable of injecting DC power into a CAT 5 or CAT 6 run, for additional rooms, or long runs, by running a separate DC cable pair to a remote location.
- **2.3** NURSE CALL CONTROLLER(S)
 - A. Furnish as needed in each nursing unit a nurse call network controller. Each controller shall provide the following:
 - B. Non-blocking, duplex communications between consoles and rooms, sub stations and duplex pillow speakers, within each 6 station loop. Provide four loops for a total of 12 speech paths.

- C. CAT 5E or CAT 6 wiring standard utilizing PoE (Power over Ethernet) between console and nurse call controllers and local wiring to power room station equipment and dome lights.
- D. VoIP audio to Nurse Call Network, VoIP Nurse console, VoIP staff terminal, wired or wireless phones via SIP protocol. VoIP digital audio stream out to rooms without IP overhead signaling.
- E. Up to 96 corridor lights can be operated with a single controller.
- F. Controller must be life safety grade meaning that it shall not require regular rebooting for continued basic functions of system and it shall be possible for controller to act as a stand-alone controller should loss of network communication occur. Personal Computers may not be used for this purpose. PCs will only be allowed outside of the UL-listed nurse call network on the customer supported LAN.
- G. Nurse call controller(s) are connected to the hospital's LAN via Ethernet switches. The nurse call servers also connected to the hospital's LAN are running specialized software for using hospital data resources and telephone communications resources.

2.4 VoIP NURSE CONSOLES

- A. Furnish as shown on plans, a UL-1069 listed VoIP nurse console capable of the following functions:
 - Full duplex audio
 - Color display
- B. 12 or 24 hours time display and synchronization to hospital standard network time from the nurse call gateway server including any daylight savings time changes supported by the network.
- C. Display up to 3 incoming calls each with an individual elapsed timer which increments time since call was placed. Also provide the ability to scroll to see all incoming calls.
- D. Power over Ethernet powered connection to UL-1069 listed Ethernet controller. No local power supplies required.
- E. Choice of hands-free duplex communications through built in speaker and separate microphone or private handset conversation.
- F. Ability to create up to 32 soft keys, user-configurable, with 4 buttons, 8 screens deep.
- G. Console shall be interactive with an associated PC workstation (user provided) without the necessity of any interconnection to the PC. The work process relationship shall be software defined through the network connections.
- H. Optional tone/mute of calls in progress.
- I. Ability to block all nurse call loudspeaker paging to facilitate a low noise patient environment. Password protection can be enabled to only allow authorized access to audio paging.

- J. Ability to swing an individual room or any group of rooms by touching one labeled touch point. Room(s) and consoles may be located anywhere within hospital nurse/patient communications network.
- K. Console can be programmed to be the receiver of any call that is not answered by another console, or can be programmed to receive any call from a console that has failed or has been unplugged, or otherwise not receiving the call (call orphaning).
- L. Ability to dial through built in key pad.
- M. Self-contained unit which shall not occupy more than 88 square inches of desk space and is desk or wall-mountable.
- N. Support manual Staff Follow functions. When Staff Follow is enabled, call-tones for a prescribed area will automatically be forwarded to the room station speaker where staff members are located. Staff location may be determined manually by entering the room number into the console or automatically using staff register stations or registration via RTLS. Pressing the call button on that station shall silence the tones. When a new call is placed, the tones shall automatically be restored.

2.5 PC CONSOLE DISPLAY

- A. Provide a PC console display on any networked OWNER provided PC that meets the system manufacturer's minimum specifications, whether it utilizes touch screen or standard mouse control. Also, OWNER provided wall mounted PC displays shall have the global option provided in this software package of a touch screen keyboard. When a PC is "associated" with a VoIP console described previously, it shall have full interoperability to provide user with easy to follow on screen functions, such as display of call priority, room and patient information. Selecting a touch point or by mouse click shall provide an automated service reminder. While in audio contact with the patient, an enriched display shall show all user defined display information, such as caregiver assigned, and pertinent patient information.
- B. The following additional functions shall be provided at each one of these users' screens:
 - Full display of all calls, including corridor light color sequence.
 - Complete electronically generated census of patients showing assigned caregiver, current patient needs as sent by service reminder process, time patient has been waiting for call answering, or need, list of caregivers on duty and staff location (when RTLS option available).
 - Ability to text message to any single individual, group of users, or all users, a text message to a pager or wireless phone display.
 - Ability to display calls in a centralized display format (i.e. Centralized Code Blue display).
 - Ability to display all staff information, staff status and wireless extension.

2.6 VoIP STAFF TERMINAL

- A. Furnish as shown on plans, as part of the nurse call communications network, a UL 1069 listed VoIP Staff Terminal. This dynamic device shall serve as a patient or procedure room communications tool while providing staff with "soft" touch-points to initiate an instantaneous notification of an in room need. Additionally this terminal may be used as a functional nurse call console.
- B. The following functions shall be provided:
 - (1) Color touchscreen display.
 - (2) Ability to create up to 60 soft keys, user-configurable, up to 8 screens per terminal.
 - (3) Sends specific need for that location. Examples: Emergency, Staff Assist, Cleaning Needed, Lifting Help, Transport, Order, Stat Order, Rounding, etc.
 - (4) Speed dial to any location
 - (5) Power over Ethernet powered connection to UL-1069 listed Ethernet switch. Local power not required.
 - (6) Full duplex audio
 - (7) Hands-free duplex communications through built in speaker and separate microphone.
 - (8) Display up to 3 incoming calls each with an individual elapsed timer which increments time since call was placed. Also provide the ability to scroll to see all incoming calls.
 - (9) Ability to dial through touch key pad.
 - (10) Ability to capture an individual nursing unit, selected units, or all units in hospital by touching single custom labeled touch point.

2.7 CAREGIVER ASSIGNMENTS AND SIGNING ON and OFF DUTY

- A. Provide software to make caregiver to patient assignments from any OWNER provided PC workstation within the hospital by easy user sign on. Assignment process shall be intuitive and indicate to that Supervisor making the assignment, each caregiver's patient load based on number of patients and patient difficulty. These assignments shall stay in queue until each individual signs on duty. The assignment is released when the caregiver goes off duty.
- B. The following additional functions shall be provided:
 - Unlimited assignment of caregivers to patients, patients to caregivers.
 - Group assignments.
 - Assignments may be made up to 7 days in advance.
 - Easy display of prior day's assignment and easy click to accept if you want to keep assignment the same.
 - Allow for assigning advanced call escalation for un-answered calls.
 - Staff member shall have ability to use Bar Code for ID and wireless devices.
 - User's assignment can print out to a local printer.
 - User shall have the ability to go ON and OFF break forwarding their device to another caregiver and reflecting this activity in the reporting software.
- C. Provide ResponderSync software interface that allows staff assignment data to be sent from Responder 5 to receiving systems that require staff assignment data. Software shall allow up to five systems to be connected to ResponderSync to receive on duty status and related staff assignments. Software must also allow for the exchange of on/off break status and device assignments, such as wireless handsets or RTLS badges.

2.8 PATIENT STATIONS

- A. Provide single patient or dual patient station as shown on plans.
- B. Each patient station shall be capable of the following functions:
 - 1. Separate speaker and microphone for full duplex audio. Entertainment audio to be muted when intercom in use.
 - 2. One DIN pillow speaker receptacle per bed that shall have a tilt design, with automatic release of pillow speaker plug when pillow speaker cord is pulled at any angle.
 - 3. Station shall support an optional module to feature bed side rail control on station to indicate bed connection. LED on station shall indicate bed connection(s).
 - 4. Built in lighting control that interfaces directly to low voltage controllers.
 - 5. One universal 1/4" jack for auxiliary alarm input/call cord per bed. Call priority of these receptacles shall be independent of any other button or receptacle.
 - 6. No dummy plugs required.
 - 7. Cancel button shall cancel any call on this station and any other station in room that is programmed for universal room cancel.
 - 8. Continuous supervision.
 - 9. Ability to service exchange station "hot" without removing system power or powering down the local controller.
 - 10. Ability to program on a per patient station basis, each bed and entertainment/call cord receptacle to custom call priorities.
- C. Supply the Enhanced Single Patient Station that includes all the features above, and additionally, two programmable buttons: code blue and staff assist for all single patient station locations.
- D. Unit shall mount in a standard 3-gang electrical box.

2.9 DUTY STATION

A. Provide as shown on plans a duty station. Unit shall provide remote annunciation of assigned patient stations and sub-stations via 4 LED's and 12 call tones. Duty station faceplate LED's shall mimic corridor light activity for the assigned nursing area. Also provides two-way duplex intercom to the assigned nurse console(s) through separate speaker and microphone. Call tones generated at duty station must be identical and repeat in synch with tones produced at closest nurse console. It shall be possible to mute the call in tone, without cancelling call. The next call in, assigned to this duty station, will un-mute the station. Muting feature may be defeated in those jurisdictions that do not allow muting of duty station. The duty station shall be capable of being programmed for a specific time that a day/night mode takes place, allowing a volume change to the call-in tones. This feature is required to minimize noise for patients. Unit shall mount in a standard 3-gang electrical box.
2.10 SUB-STATIONS

- A. Provide as shown on plans, sub-stations which shall be flush mounted in a single gang box. All substation cancel buttons will follow the cancel policy as defined in the system configuration. Typically canceling a high priority call can only be accomplished by the station initiating a call, while lower priority calls may be cancelled by any associated station in the room.
- B. Individual sub-stations shall be:
 - Pull cord station shall be water resistant with a replaceable PVC pull-cord, and easily cleaned surface. The pull-cord shall have a large, easy to pull plastic "bell" attached. This station may only be cancelable with the room and not cancelable from the nurse console. Station shall have the addition of one extra pushbutton for call-in. This button shall be programmable separately from the pull-cord to indicate a different call process (i.e. call caregiver to return to bed) than the pull cord which may indicate an emergency situation. Although this station trims out to a double gang faceplate, the mounting is in a single gang box. Pull cord station shall be installed in all shower/tub locations.
 - Pull cord station with Speaker shall have all the capabilities of the pull cord station with call button, and include a built in speaker and microphone for communications with the patient. Although this station trims out to a double gang faceplate, the mounting is in a single gang box. Pull cord station with speaker shall be installed in all non-shower/tub locations.
 - Single call button station and Dual button stations shall be water resistant. The buttons shall be back lit and have the ability for a user defined customized call label corresponding to the 990 call priorities available within the system. An elapsed timer may be activated by any call button to start a count up timer on any clock that accepts remote activation.
 - Single and Dual call button station can have an optional Clear Cover to prevent accidental initiation of the call buttons. Clear Cover is easily lifted to access buttons and does not cover the Cancel button for easy cancelation of calls.
 - Bed Status station shall have four backlight buttons: Transport, Cleaning Needed, Cleaning in Progress, Bed Ready. The buttons will indicate the room condition and alert transportation personnel to this room. When the Transport button is depressed, the transport person assigned to this area receives a wireless message to transport this patient, or alternately, transportation dispatcher receives an on screen display. Environmental Services staff will receive a wireless message that this bed requires cleaning. Environmental Services and nursing supervisors are alerted to the bed's state. Alternately, customized descriptions can be assigned to this station for specific facility needs. Canceling an event maybe accomplished by pressing a button a second time, using the cancel button, or by pressing another button in the chain of events.
- C. A two jack auxiliary alarm station shall allow the connection of external patient monitoring devices via two (2) ¼ inch jacks. This allows individual annunciation of patient alarms to nurse call consoles and wireless devices. Each jack may be programmed for one of 990 call processes and may be configured for latching or non-latching. A call in timer may be set within system configuration to buffer a device that produces intermittent alarms.

2.11 CORRIDOR LIGHTS AND DOMELESS CONTROLLERS

Project No. 121505 Nurse Call System Section 27 5223 - 8

- A. Provide as shown on plans, the proper type of corridor light or domeless controller. Corridor lights shall contain four sections, each lighted by a long life, RGB LED capable of producing 7 colors. Each section shall have a diffusion lens which allows for 180 degree horizontal visibility of call lights. The corridor lights shall be capable of the following:
- B. All segments of corridor light can indicate a call in any of the following 7 colors: Blue, Red, White, Green, Orange, Yellow, or Pink.
- C. Custom call patterns (any combination of light segments, such as all segments blue for code blue).
- D. Flash any single color or strobe the sections of the light in any color pattern.
- E. Intelligence in the corridor light and domeless controller shall support up to 16 room devices and allow for the ability of any room station to be associated with any other room in the system. This allows special functions where needed, such as associated call stations and cancelling options, (i.e. door monitoring).
- F. Staff registration shall be indicated by a custom color associated with that staff level (i.e. Green = Nurse, Orange = LPN, Yellow = Aide).
- G. Domeless controllers shall have all the function of the corridor light, less LED's.
- H. In the unexpected event of communications loss with the nurse call controller, corridor lights and domeless controllers shall enter a local room failsafe mode showing all calls in the hallway via the LED indicators.
- I. Corridor lights and domeless controllers may be hot-swapped on the room-to-room communication line without the loss of communications to other devices on the local network.

2.12 PATIENT ENTERTAINMENT SPEAKER/CALL CORDS

- A. Provide one (1) pillow speaker per bed station and 5% spares. The pillow speaker shall have a mating 9 pin din plug and nurse call button. Digital TV control with full duplex communications via built in microphone and separate speaker. There shall be three additional buttons for the use by the patient for special needs, such as "pain", "water", and "toilet". The system shall have the ability to discern the difference between these calls and send it to the appropriate care level. Buttons for up/down volume, up/down channel. TV mute, closed caption and TV on/off shall be standard. A direct entry key pad gives patient ability to enter channel number. Pillow speakers shall control up to two lights. All pillow speakers to have call assurance and monitor LED's.
- B. For television installations where the nurse call will provide channel and volume control, the nurse call vendor shall be responsible for all wiring interconnects and terminations, including those from the wall plate to the television unit.

2.13 WIRELESS DEVICE INTERFACES

A. The Telephony Interface Software Module shall receive, via an Ethernet connection, VoIP connectivity using the standard SIP protocol. This module shall support up to 60 simultaneous voice connections between wired/wireless phones and the nurse call network.

Project No. 121505 Nurse Call System Section 27 5223 - 9 B. The facility will utilize a wireless phone system which is not SIP compatible and a VoIP/SIP PBX. The software module shall directly support an interface through the OWNER provided Telephony/SIP Call Server that communicates to the nurse call network gateway server. The supplying contractor is to provide middleware which interfaces the non SIP wireless phone system display to the nurse call system software module. OWNER provides wireless phone system OAI. OWNER will also provide a Telephony/SIP Gateway.

2.14 ADT INTERFACE

- A. Provide a HL-7 compliant interface (V2.2 2.5) for the purpose of receiving relevant patient information.
- B. This interface shall be capable of the following:
 - 1. Mapping of standard ADT segment field components and subcomponents to nurse call fields.
 - 2. All updates shall be real time, but software shall buffer data for any interruption of service
- C. This interface shall allow data to flow bi-directionally, from Responder 5 to ADT, and from ADT to Responder 5.

2.15 DATABASE MANAGEMENT

A. Provide standard ODBC (MS SQL 2005) compliant databases. Databases shall be able to be backed up using facilities standard backup processes and disaster recovery methods.

2.16 REPORTING SOFTWARE

- A. Provide software that may be accessed by any networked PC work station that gives management patient call details in clear readable format. HL-7 integration shall make all pertinent patient details available, including the ability to search by patient name and/or patient ID number for those nurse call records associated for that patient during their stay, regardless of room/bed occupied.
- B. In addition, the reporting software shall provide the following functions:
 - 1. Standard, global reports.
 - 2. Individual user reports.
 - 3. Reports shall be viewed in Adobe Acrobat Reader.
 - 4. Any trained individual may utilize standard ODBC compliant reporting software to generate more enhanced reporting.

PART 3 - EXECUTION

3.1 SUPERVISION

- A. Only factory certified installers shall install, service and maintain the specified network system.
- B. Manufacturer shall have the equipment manufacturer's engineer or their designated agent inspect the installation and operation of this network to determine that the network complies with all standards listed in Par. 1.01.

Project No. 121505 Nurse Call System Section 27 5223 - 10

3.2 TRAINING

A. Contractor shall provide thorough training of all nursing staff assigned to those nursing units receiving new networked nurse/patient communications equipment. This training shall be developed and implemented to address two different types of staff. Floor nurses/staff shall receive training from their perspective, and likewise, unit secretaries (or any person whose specific responsibilities include answering patient calls and dispatching staff) shall receive operational training from their perspective. A separate training room will be set up that allows this type of individualized training utilizing inservice training unit, prior to use of the new system.

3.3 NEEDS ASSESSMENT

A. Contractor shall provide a one-on-one meeting with the particular nursing manager of each unit affected by the installation of the new networked nurse/patient communications equipment. This meeting shall include reviewing the floor plan drawing, educating the nursing manager with the functions of the equipment that is being provided and gathering details specific to the individual units; coverage and priorities of calls; staffing patterns; and other pertinent details that will affect the training. In-service Scheduling materials and sample of training materials will be provided. A staff member list and Pocket Page Tag Message list, if needed, be filled out for inclusion in the software. Information gathered will be programmed into the network software.

3.4 WIRING

- A. Contractor shall terminate all wiring with manufacturer approved connectors. The use of wire nuts is prohibited.
- B. All wiring shall be free from shorts and faults. Wiring shall be UL listed, NEC and NFPA 70, Article 25 approved.
- C. Nurse patient communications network wiring shall not be run in the same conduit with other systems (i.e. Class 1 AC power distribution, fire alarm, entertainment systems, lighting controls, etc.).
- D. For television installations where the nurse call will provide channel and volume control, the nurse call vendor shall be responsible for all wiring interconnects and terminations, including those from the wall plate to the television unit.

3.5 ELECTRICAL POWER CONNECTIONS

- A. It shall be the responsibility of the Contractor to provide a dedicated 120 VAC, 60 HZ critical branch circuit feed into the equipment cabinet. This power feed shall not have any other devices connected directly to it. A 20 AMP circuit breaker located in the electrical sub-panel labeled "nurse call" will control this circuit. This electrical circuit will be connected to the hospitals emergency power system for automatic power switch over during loss of utility power.
- B. Connect all network system power supplies and equipment cabinets to a common earth ground utilizing a 14 AWG, or larger, solid conductor which is at minimum the same conductor size as the AC feed wires.

3.6 ENVIRONMENTAL PROTECTION OF NETWORK DEVICES

- A. Make certain that all network control equipment is accessible for service. Contractor shall notify specifying authority if designated equipment closet does not meet manufacturer's requirements for heat, radiation or static electricity.
- B. Contractor shall protect network devices during unpacking and installation by wearing manufacturer approved ESD wrist straps tied to chassis ground. The wrist strap shall meet OSHA requirements for prevention of electrical shock, should technician come in contact with high voltage.

3.7 CLEANING AND PATCHING

- A. It shall be the responsibility of the contractor to keep their work area clear of debris and clean area daily at completion of work.
- B. It shall be the responsibility of the general contractor to patch and paint any wall or surface that has been disturbed by the execution of this work.

3.8 DRAWINGS

A. Provide as built drawings of all installed network components and associated wiring on building plans.

END OF DOCUMENT 27 5223

SECTION 28 0537 SECURITY VOICE COMMUNICATIONS - DISTRIBUTED ANTENNA SYSTEM

PART 1 – GENERAL

1.1 SCOPE OF WORK (SOW)

- A. The scope of work of this specification describes technical and performance criteria for deploying a Security voice communications systems Neutral-Host Distributed Antenna System (DAS) capable of supporting Public Safety Networks (PSN). The DAS components specified in this document include devices such as: Donor Antennas, Coverage Antennas, Coax Cable, Coax Connectors, lightning protectors, grounding kits for coaxial cables, Splitters, Combiners, Couplers, , Bi-Directional Amplifiers (BDA), Fiber-Optic Cable, Fiber-Optic Connectors, Fiber-Optic Jumpers, Fiber-Optic Master Unit and Fiber-Optic Remote Units.
- B. Because of the substantial differences in topologies available in the market for DAS, the design drawings and specifications are not meant to be a set of construction drawings, but a performance criteria base to be used by the Radio Frequency System (RFS) installer of this system to create the final construction and permit documents. It is therefore in the scope of work of this system to provide a complete design for the review of the architect and engineer (A&E) of the project.
- C. The scope of work also includes the following services:
 - 1. A software model of the building to determine the best locations of all the coverage antennas including heat map representations and modeling of all the different construction materials used in the construction of this building. Examples of this software is the modeling software offered by IBwave Systems.
 - 2. A wireless survey done with a spectrum analyzer of all areas of the building to verify and ratify the final locations of coverage antennas, before the system is installed but the structure of the building is already installed.
 - 3. A final survey of the building after the system is installed to verify and document in drawings all measured signal levels in all areas of the building (approximately one measure point for every 100 sqft. in the building at all levels).
- D. The scope of work includes, all submittal indicated in the documents, programming of the system, coordination with other trades in the job site, warranties, testing and as-built documentation.
- E. It is also the responsibility of the RFS installer to mediate and process the agreement to rebroadcast the DAS frequencies between the building owner and Public Safety First Responders Support Entity (PSN FRSE). This entity is the agency/department who maintains and supports the radio communications infrastructure for the First Responders (Fire Rescue, Police and EMS) a local jurisdiction.

1.2 BIDDING AND PRICING

A. The Distributed Antenna System as described in this section shall be its own category and line items in the pricing documents and shall include all cost associated with this system as specified in this section.

1.3 RELATED DOCUMENTS

- A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. All UTP 4-pair Cabling and Single Mode fiber optic cabling used in this project for the DAS shall be supplied and installed as per specification section 271000.
- C. All raceways and conduits used in this project for the DAS shall be governed by specification section 270528

1.4 SYSTEM DESCRIPTION

- A. This specification outlines an In-Building Wireless (IBW) Distributed Antenna System (DAS). The system must extend wireless services digitally throughout the building. The system must be flexible, scalable, multi-band and multi-protocol solution.
- B. The system platform shall be scalable to allow for easy system growth in size and scope of solution to reach new in-building service areas or to add bandwidth and capacity as necessary.
- C. The system must support the technologies used by the PSN FRSE in the area where the project is installed providing edge-to-edge bandwidth for all frequencies used by them. It must also offer an element management system that includes on-site or remote accessible system alarming and management of network elements.
- D. Services: Upon commissioning, the DAS shall provide coverage for the PSNs listed below on all frequencies currently being used by this system. **Confirm with AHJ and Owner actual frequencies to be implemented at time of installation.**
 - 1. 700 MHz PSN
 - 2. 800 MHz PSN
- E. PSN Approval: The RFS Installer shall propose and deploy a DAS system capable of receiving approval by the Public Safety Network Authority Having Jurisdiction PSN AHJ. The DAS shall also be in compliance with NFPA 72 and NFPA 1221.
- F. Architecture. The architecture of the system shall be based on donor antennas located in the exterior of the building, feeding one or more Bi-Directional Amplifiers (BDA). These BDAs shall feed the distribution system and the local antennas that radiate the signal in both directions to the hand held devices used by the PSN FRSE. Architectures based on twisted pair cable to the distribution antennas or distribution antennas that require local power shall not be acceptable
- G. Coverage: Different from what is required in NFPA codes, the DAS shall be designed to provide 100% coverage of the building with the minimum signal levels required by the prevailing code for the area where the project is located.
- H. Broadband Active Distribution: If the building area is very large and amplification is required to cover some areas, the design shall include the use of single-mode fiber-optic cable for active distribution. In-line copper amplifiers are not allowed. Coverage antennas requiring local power supplies will not be allowed. All power for coverage antennas must come from the DAS head end system.

- I. Supervision: The DAS system shall be monitored by the Fire Alarm system to comply with NFPA 1221 requirements. The RFS installer shall coordinate with the installer of the Fire Alarm system for proper integration.
- J. Management: The DAS system shall be provided with a web-browser management interface that allows configuring, management and error reporting of active equipment part of the DAS system.

1.5 RFS INSTALLER QUALIFICATIONS

- A. The installer of this system (RFS Installer) shall be a company regularly engaged in the installation of this type of system for the last five (5) years.
- B. The RFS installer shall have had installed at least 20 systems similar to this one, in the last five (5) years. The RFS installer shall provide a list of completed projects with contact information from the end user side.

1.6 MATERIALS ALTERNATES AND SUBSTITUTIONS

- A. General: See details for alternates and substitution in specification section 270010.
- B. There are no acceptable substitutions for any parts of this system.

1.7 SUBMITTALS

- A. The RFS installer shall follow all requirements for shop drawings indicated in specification section 27001.
- B. Submittal Requirements:
 - 1. RFS Installer qualifications
 - 2. Product Data: Submit manufacturer datasheets for the following components:
 - a. Donor and Coverage Antennas
 - b. Coaxial Cable and Connectors
 - c. Splitters, Combiners and Couplers
 - d. Bi-Directional Amplifiers (BDA)
 - e. Fiber-Optic Master Unit
 - f. Fiber-Optic Remote Units
 - 3. Shop Drawings: Submit the following items:
 - a. RF link budget
 - b. Signal to Noise Interference Ratio (SNIR) Map
 - c. Overlay of system Components on floor plans
 - d. Drawings for Donor Antenna and grounding
 - e. Bill-of-Material (BOM)
 - f. Heat maps for all frequencies
 - g. Battery calculations for the DAS
 - h. Complete IBwave reports
 - 4. Statement of Work (SOW): Submit sample SOW
 - 5. Acceptance Test Plan (ATP): Submit sample ATP
 - 6. Recommended Spares
 - 7. Maintenance Service Pricing

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 121505 Security Voice Communications - DAS s Section 28 0537 - 3

- 8. Warranty Documents:
 - a. Submit for all manufactured Components specified in this Section.
 - b. Submit RFS Installer's System Warranty.

1.8 ABBREVIATIONS AND ACRONYMS

- A. ACG: Automatic Gain Control
- B. AHJ: Authority Having Jurisdiction
- C. ATP: Acceptance Test Plan
- D. AWS: Advanced Wireless Service
- E. BDA: Bi-Direction Amplifier
- F. BOM: Bill-of-Material
- G. BRS: Broadband Radio Service
- H. C/N: Carrier-to-Noise Ratio
- I. DAS: Distributed Antenna System
- J. FCC: Federal Communications Commission
- K. GUI: Graphical User Interface
- L. MTBF: Mean Time Between Failure
- M. NFPA: National Fire Protection Association
- N. NMS: Network Management System
- O. PCS: Personal Communications System
- P. PSN: Public Safety Network
- Q. RoHS: Restriction of Hazardous Substances
- R. RSL: Received Signal Level
- S. SNIR: Signal-to-Noise Interference Ratio
- T. SOW: Statement of Work
- U. VSWR: Voltage Standing Wave Ratio

1.9 **DEFINITIONS**

A. Acceptance: Expressed approval by the customer

- Β. Active: DAS components that require AC/DC power for operation
- C. Carrier Approval: Expressed approval to interconnect to the WSP macro network
- Channel: A path for an RF transmission between two points D.
- E. Component: A main system element of the DAS
- F. Passive: DAS components that do not require AC/DC power for operation

PART 2 - PRODUCTS

2.1 COMPONENTS

- Α. Donor signal. For this project, the Donor signal will come from a roof mounted donor antenna.
- Β. Broadband Donor Antennas: Selected based on signal survey.
- C. Omni-Directional Coverage: Omni-Directional Coverage antennas shall feature a multi-band design, accommodating multiple frequency bands in a single small antenna. This antennas shall be selected based on the system architecture and based on the software modeling.
- D. For all fiber optic passive components specification section 271000 shall be followed.
- E. Splitters, Combiners, Couplers, Coax Jumpers and Connectors:
 - Approved Manufacturer: Commscope, Times Microwave Systems or equivalent. 1.
- F. Bi-Directional Amplifier (BDA): The BDA for this project shall be a unit capable of receiving and transmitting any RF life safety signal within the frequency range of the DAS system without any changes in protocols, or any data conversion. The BDA shall have the following specifications:
 - 1. Enclosure: NEMA 4X, painted red
 - 2. Bandwidth: The unit shall work in the 700/800 MHz band and FirstNet LTE Band
 - Class: Class A (Digital Channelized) 3.
 - Channels per band: 32 4.
 - Power per band: 2W per channel for buildings larger than 100,000 sqft and 0.5W for 5. buildings smaller than 100,000 sqft
 - Channelized uplink (AGC): required. 6.
 - Channelized uplink squelch support: required. 7.
 - 8. Web base interface and support for SNMP traps (v. 2 and v.3): required.
 - Built-in Isolation test: Required. 9.
 - Dry contacts for alarms per NFPA 1221: required. 10.
 - 11. Basis of design: Comba Telecom, Solid or approved equal
- G. Universal Multiband, Multi-service software based repeater platform (Node). This unit provides digital programmable filtering to select the signals that will be propagated in the DAS system.

JFL - THS 5 ACRE LAND LEASE SITE Project No. 121505 Procurement Package 07/21/2023 **TLC** Engineering Solutions

This unit shall be manageable and have the ability to transmit SNMP alarms. This unit shall be modular and shall be provided with the proper cards for covering all frequencies listed in this specification.

- 1. Approved Manufacturer: Harris, Solid, Commscope or Approved equal.
- H. Base Station Interface Unit (BIU). For the downlink path, the BIU shall receive simplexed signals from the RF signal source. The BIU shall independently filters, attenuates and controls each signal and transmits these to the system's Optical Distribution Units (ODU). Each BIU shall consists of up to two MDBUs (SISO chassis) or up to two MDBUs (MIMO chassis) and can support up to nine or 17 discrete inputs per sector, respectively (four per MDBU and one V/UHF combined input on the BIU chassis). Supported bands include VHF, UHF, 700MHz, 800MHz, 850MHz, 900MHz, 1900MHz, 2100MHz, and 2500MHz TDD. This BIU shall be classified as a Class A system.
 - 1. Approved Manufacturers: Harris, Solid, Commscope or Approved equal
- I. Optical Distribution Unit (ODU). This unit shall convert all RF signals to a fiber optics signal for transmit and receive to the different Main Remote Units (MRU).
 - 1. Approved Manufacturers: Harris, Solid, Commscope or Approved equal
- J. Fiber Remote Units (FRU). The FRU shall convert the optical signals back to RF signals and transports them across coaxial cable to the DAS omnidirectional antennae which radiate the wireless signals within the corresponding sector to the user equipment. For the uplink, the signal follows the reverse path using the same equipment. The units shall provide monitoring status for code compliant.
 - 1. Approved Manufacturers: Harris, Solid, Commscope or Approved equal
- K. DAS Management System (DMS). The DAS Management System shall be a network management device that provides remote control and monitoring of the DAS through a standard Internet connection.
 - 1. Approved Manufacturers: Harris, Solid, Commscope or Approved equal
- L. DAS Annunciator and Monitoring Panel: The Das system shall include a DAS annunciator and monitoring panel as required by code. The specifications of this unit shall be:
 - 1. It shall include a rechargeable battery to provide 24 hours of backup power.
 - 2. The unit shall include built in LED indicators to notify the different alarms.
 - 3. The unit shall provide status indicating for the following elements of the DAS system
 - a. The BDA
 - b. The donor Antenna
 - c. AC power
 - d. Battery Capacity
 - e. Battery Charger
 - f. System Status

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

- 4. The unit shall include Form-C relay contact for interfacing to a fire alarm panel, for all signal inputs.
- 5. The unit shall be housing in a NEMA-4 enclosure and capable of monitoring the communications link for integrity.
- 6. If the BDA does not offer an output for monitoring the donor antenna, the system shall be provided with a bias-T fitting in the donor antenna cable to monitor the status of the donor antennas.
- 7. Basis of design: DAS alert Model 1221A

2.2 RACEWAYS FOR DAS SYSTEM

- A. All raceways for the DAS shall have a survivability level 1 [2] [3], as defined in NFPA 72 and as required by the AHJ.
- B. All equipment for the DAS system shall be installed inside a NEMA 4 metallic enclosure. For the head end system, use an outdoor rated free standing cabinet. For smaller equipment, use a wall mounted enclosure (no less than 36" X36"X8") with a hinged door and lock. All enclosures and cabinet shall be painted red and shall include a label indicating it is Fire Department Equipment and the name of the company who supports the system and contact information.

2.3 COAXIAL CABLE – PLENUM RATED

- A. Coaxial cable for DAS applications shall be selected based on the attenuation expected based on the software simulation for the location of the antennas. At a minimum the coaxial cable for DAS system shall have the following specifications:
 - 1. Impedance: 50 Ohms ± 2
 - 2. Cable type: $\frac{1}{2}$ corrugated cable
 - 3. Center conductor: Copper-clad aluminum
 - 4. Outer conductor: Corrugated aluminum or corrugated copper
 - 5. Dielectric: Air or PE(F)
 - 6. Maximum frequency: 10 GHz
 - 7. Listing: CMP jacket, regardless if the space is a plenum or not or if the cable is pulled inside conduit.
 - 8. Cable approvals: NFPA-262, UL-444
- B. Coaxial cables for DAS system shall be run in conduit at all times or for retrofit applications where space is at a premium, cable inside a metal raceway will be acceptable.
- C. Approved manufacturer: Trilogy, RFS, Pasternack, or approved equal

2.4 COAXIAL CABLE – 2 HOUR RATED

- A. When coaxial cable is used to comply with survivability level 2 or 3, and the cable is not run inside a 2-hour chase, the coaxial cable shall have an integral 2 hour rated protection for survivability requirements. These cables shall still be run inside conduit. The 2-hour rated cables shall have the following specifications:
 - 1. Impedance: 50 Ohms ± 2
 - 2. Cable type: $\frac{1}{2}$ corrugated cable

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package Security Voice 07/21/2023 TLC Engineering Solutions

Project No. 121505 Security Voice Communications - DAS Section 28 0537 - 7

- 3. Outer conductor: Corrugated aluminum or corrugated copper
- 4. Dielectric: Air or PE(F)
- 5. Maximum frequency: 1 GHz
- 6. Listing: CMP-CI jacket, regardless if the space is a plenum or not or if the cable is pulled inside conduit.
- 7. Cable approvals: NFPA-262, UL-444 and UL-2196
- B. Approved manufacturers; Trilogy, RFS or Comtran

2.5 FIBER OPTIC CABLES FOR DAS SYSTEM

- A. When 2-hour rating for the fiber optic cable is not required for the DAS system, please follow all specification for fiber optic cables indicated in specification section 271000. When the design of the DAS system for life safety requires fiber optic cables 2 hour rated, the following product specification shall be followed.
 - 1. Cable jacket shall be a rise rated low some LSZH jacked.
 - 2. Cable approvals: UL 1666, UL 1685 and UL 1651
 - 3. Cable approvals for fire resistivity: IEC 60331-25
- B. Design selection: Draka QFCI cable

2.6 POWER BACKUP

- A. All DAS equipment shall be powered through emergency power branch circuit and shall be feed through a UPS system with a 12 hours of battery backup. The RFS installer shall estimate the required capacity of the UPS and the required battery backup. The UPS selected for this system shall have a monitoring card using dry contact relays to notify the faults, so they can be supervised.
- B. Because of code requirements to house DAS equipment in NEMA 4X enclosure, the Uninterrupted Power Supply (UPS) system used to power the DAS system shall be based in outdoor rated UPS. The UPS system shall have monitoring capabilities through dry contact relays. Basis of Design Alpha Micro (Outdoor UPS units) with monitoring card or approved equal.

2.7 SUPERVISION OF DAS SYSTEM

- A. All DAS equipment shall be supervised as required by NFPA 1221. The monitoring shall happen through the fire alarm system and a dedicated remote annunciation panel located in the fire command room.
- B. The scope of work for the monitoring shall be, not only for the head end but also for all the fiber remotes and the UPS units providing power to all components of the system.
- C. The monitoring if the system shall happen through the Fire Alarm System (FAS), by means of monitoring modules connected to the DAS annunciator and monitoring panels. The FAS shall

have a dedicated annunciator panel for the DAS system located at the main entrance to the building or inside the Fire Command Room.

2.8 IDENTIFICATION AND LABELING TAGS

A. The RFS installer shall follow labeling materials indicated in specification section 270010

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: The RFS installer shall follow all installation practices indicated in specification section 270010.
- B. The RFS installer shall design, install, commission and test the DAS in accordance with the manufacturer's instructions and recommendations.
- C. All FODCs for fiber the optics cables feeding the DAS system shall be installed inside the NEMA 4X enclosures or cabinets holding the DAS equipment.

3.2 PERFORMANCE REQUIREMENTS

- A. The PSN DAS shall comply with NFPA-72 and NFPA 1221.
- B. Installers shall state the assumed channel count for the PSN Frequency Bands identified above in Section 1.3. with submittal of bid response. Prior to installation, installers shall confirm the channel count and frequencies with the AHJ, and shall guarantee coverage for these channels per the criteria stated above.

3.3 SYSTEM WARRANTY AND SERVICE

- A. General: The RFS installer shall follow all warranty and service requirements indicated in specification section 270010.
- B. All Fiber optics cabling for the DAS system shall be covered in the same warranty for the structured cabling system indicated in specification section 271000.

3.4 ENGINEER'S FINAL ACCEPTANCE TEST

- A. General: The RFS installer shall follow all test requirements indicated in specification section 270010
- B. Additional testing requirements for the RF system:
 - 1. All antenna feed lines shall be RF swept with TDR to determine proper installation without kinks or damage to the coax

3.5 TRAINING AND INSTRUCTION

A. General: The RFS installer shall follow all training requirements indicated in specification section 270010.

3.6 AS BUILT DOUCMENTS AND CLOSE OUT INFORMATION

- A. General: The RFS installer shall follow all as built and close out information requirements indicated in specification section 270010.
- B. Additional requirements for as built documentation shall include:
 - 1. Donor antenna, grounding and lighting protection details
 - 2. Cable routing, splitters, couplers and coverage antenna locations
 - 3. Active component locations, layout and configuration
 - 4. Test Reports. PSN: Submit Accepted ATP reports confirming the requirements of part 3 of this specification.
 - 5. Field Reports: Submit sweep-testing results for all cable runs.
 - 6. Field Reports: Submit OTDR test results for all fiber runs.
 - 7. Copy of the signed agreement for frequency re-broadcast between owner and PSN FRSE.

END OF SECTION

SECTION 28 1000 ELECTRONIC SECURITY SYSTEMS

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. The scope of work shall include furnishing all labor, materials, enclosures, wiring, equipment, programming, training, testing, documentation and warranty support, required to provide a completely operational and working Security System.
- B. The Security System Installer (SSI) shall coordinate with the door frame installer, the door installer, the door hardware installer and gate installers on the placement of all electronic locking hardware and door controls for this project. The SSI shall provide the low voltage power supplies for all electric locks, wire and cable, terminate all connections, and shall interface this equipment with the integrated security system.
- C. All materials for the structured cabling system (4-pair UTP cables, fiber optic cables and 24-AWG multi-pair (25 pairs or higher) components required for the security system shall be in compliance with specification Section 271000.
- D. The scope of work for this specifications also include the following items:
 - 1. The supply, installation and programming of the monitoring system for the Defibrillator units (AED)
 - 2. The supply, installation and programming of the Video Intercom system.
 - 3. The supply, installation and programming of the Emergency/Assistance call station stations.
 - 4. The programming of the access control software including the integration described in this specification section.
- E. The following parts of the system are not part of this contract:
 - 1. All networking equipment (switches, routers, etc) for the operation of the system
 - 2. Software licenses for the electronic security systems beyond the 36 months included in this contract.

1.2 RELATED DOCUMENTS

- A. General Terms and Conditions of the Contract Documents
 - 1. Division 8 Door Hardware
 - 2. Division 26 Electrical
- B. Supplemental: Refer to the specification sections identified below for additional requirements, which are supplemented by this section.
 - 1. 270010 Technology General Provisions
 - 2. 270528 Raceways for Technology
 - 3. 271000 Structured Cabling System
 - 4. 270526 Grounding and Bonding for Communication Systems
 - 5. 282000 Video Surveillance System

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 121505 Electronic Security Systems Section 28 1000 - 1

1.3 SECURITY SYSTEM INSTALLER QUALIFICATIONS

- A. The SSI selected for this project must be a direct manufacturer authorized representative of the product they propose to provide. All technicians assigned to install and configure this system shall be factory trained and certified for the proper installation of this equipment. The SSI must have a minimum of 5 qualified and factory trained technicians to support this system. This company must be of established reputation and experience, regularly engaged in the supply and support of such systems for a period of at least five consecutive years. This company shall have a fully staffed office of sales and technical support representatives.
- B. Other required SSI qualifications are:
 - 1. The SSI shall agree, in writing, as part of their proposal, to provide both warranty and non-warranty service within 24 hours of notification of a problem. The CI shall be able to perform any and all repairs to the system within 48 hours.
 - 2. The SSI, as a minimum, must carry a current limited energy license.
 - 3. The SSI shall have staff trained in programming the system as described in this specification. The SSI shall submit as part of the qualifications required, the resume of the programmers for the systems as well as the training certificates for this staff from the manufacturer of the system.

1.4 MATERIALS ALTERNATES AND SUBSTITUTIONS

- A. General: See details for alternates and substitution in specification section 270010.
- B. Due to compatibility issues with other buildings under the control of the owner, the only approved system to be provided in this project is Honeywell Pro-watch Integrated Security Suite. Substitutions will not be allowed.
- C. Sensors or door security devices with the exception of card readers shall allow for substitutions.

1.5 SHOP DRAWINGS AND SUBMITTALS

- A. The SSI shall follow all requirements for shop drawings indicated in specification section 270010.
- B. The submittal process for this scope of work will be a two stage process. The first stage is the product/installer approval. Within 30 business days of receiving contract approval and notice to proceed, the following items shall be submitted to the A&E for review and approval, as part of the product/installer approval process.
 - 1. Proof of Installer qualifications, addressing all requirements of paragraph 1.3 of this specification.
 - 2. Product numbers, specifications, and data sheets for all equipment.
 - 3. Data sheets and samples of all labeling materials and equipment to be used in the project.
 - 4. A complete explanation of the identification method to be used for all equipment and cabling part of the security system.
 - 5. Data sheets of all termination blocks and mounting accessories to be used in the project. A paragraph shall be added before each data sheet indicating the intended use of each type of termination block.
 - 6. Detailed drawings of all custom products to be used in the project.
 - 7. Data sheets for all wire and cable to be used as part of this system. A paragraph shall be added before each data sheet indicating the intended use (to connect what type of devices) of each cable.

- C. The second stage of the submittal process is the shop drawing process. Shop drawings shall only be submitted after all portions of the product/installer approval have been accepted by the A&E. The following information is required as part of the shop drawings:
 - 1. Floor plans indication all devices to be provided and all cable runs to all devices or junction boxes. Access controlled doors shall have the door name. All other devices shall have a unique identifier, as they will be programmed in the system.
 - 2. Point to point wiring diagrams indicating all termination points for each conductor and for each device, cable types and color coding of each termination. These diagrams shall be submitted for each door type and for each type of device in the system.
 - 3. Panel schedules in a table format, indicating all ports being used and what device is connected to each port. Panel schedules shall be submitted for all access control panels, alarm panels, fiber optics distribution frames, Ethernet switches, patch panels, termination blocks, etc.
 - 4. Completely fill out network configuration template provided by TLC Engineering upon request, to explain all network devices to be used in a project and to get IP addresses from the network administrator.
 - 5. Overall system diagrams indicating all head end components, their room location, and all configuration characteristics like IP addresses, serial ports used, etc.
 - 6. Termination details for multi-conductor connectors and other details not included in item 2 of the shop drawings.
 - 7. Outline of the testing process.
 - 8. Training syllabus for all systems included in this scope.

1.6 ABBREVIATIONS

- A. Additional abbreviations used in this document:
 - 1. ADA Americans with Disabilities Act
 - 2. API Application Programming Interface
 - 3. ASCII American Standard Code for Information Interchange
 - 4. BPS Bits Per Second
 - 5. DIN German Institute of Standardization
 - 6. DPS Door Position Switch
 - 7. FCC Federal Communications Commission
 - 8. GUI Graphical User Interface
 - 9. ID Identification
 - 10. I/O Input /Output
 - 11. ISC: Intelligent System Controller
 - 12. ODBC Open Database Connectivity
 - 13. O&M Operations and Maintenance
 - 14. PIN Personal Identification Number
 - 15. PTZ Pan/Tilt/Zoom
 - 16. RAID Redundant Array of Independent Disks
 - 17. REX Request to Exit
 - 18. RoHS Restriction of Hazardous Substances Directive
 - 19. SCS Security Control System
 - 20. SDRAM Synchronized Dynamic Random Access Memory
 - 21. STP Shielded Twisted Pair
 - 22. UL Underwriters Laboratories, Inc.
 - 23. UPS Uninterrupted Power Supply
 - 24. USB Universal Serial Bus
 - 25. UTP Unshielded Twisted Pair
 - 26. VOC Volatile Organic Compounds

1.7 GLOSSARY OF TERMS

- A. The following terms are defined for the purposes of this specification:
 - 1. Access Group: A logical group of card readers (terminals) which may be connected to one or more sub-controllers and which represent a collection of readers for which a particular cardholder may have access privileges.
 - 2. Access Mode: The mode of operation in which the security control system shall only annunciate tamper and trouble conditions at a monitored point. Alarm conditions shall not be annunciated in this mode. Also referred to as alarm shunting.
 - 3. Acknowledge: The action taken by a security control system operator to indicate that he/she is aware of a specific alarm or tamper state.
 - 4. Action Messages: A set of instructions automatically provided to the operator when an alarm condition is generated.
 - 5. Advisory: A message provided by the security control system to the operator to inform him/her of a condition as reported by the security control system.
 - 6. Alarm Condition: A change of state, as sensed by the security control system, indicating that the security control system has detected a condition which its sensors were designed to detect.
 - 7. API Integration: a method to transfer information between two systems by means of APIs, though an Ethernet communication network.
 - 8. Cardholder: A person who has been issued a valid access card.
 - 9. Card Reader: A device usually located at access points, designed to decode the information contained on or within a card key credential for the purposes of making an access decision or for identity verification.
 - 10. Clear: The action taken by a security control system operator to respond to an alarm condition or advisory so that other alarms may be serviced or so that other actions may be taken.
 - 11. Download: To send computer data from the File Server to a controller for the purposes of making access decision without the intervention of the File Server.
 - 12. Facility Code: A coded number, in addition to the individual card number, stored within each card key that uniquely identifies the facility at which the card is valid. This feature prevents cards from one facility from being used at another facility that has a similar access control system.
 - 13. File Server: Primary host computer in the networked security system which maintains the access control system database.
 - 14. Line Supervision: The monitoring of an electrical circuit via electrical and software systems to verify the electrical integrity of the supervised circuit.
 - 15. Off-line: A condition in which a controller(s) is not in communication with the File Server. In the off-line mode, the controller continues to make access decisions and process alarms according to the information stored at its local database.
 - 16. Password: A combination of numbers or letters unique to security control system operator which defines commands and data fields he/she may view, edit, or command.
 - 17. Relay integration: A method to transfer signals between two systems by means of using potential free contact closures to input points.
 - 18. Reset: A command or feedback signal that indicates that a monitored point has returned to its normal state after having transferred to the alarm or trouble state.
 - 19. Secure Mode: The normal state of an alarm input point from which it will be monitored for change of state to either an alarm or trouble condition.
 - 20. Secured Area: A physical location within the facility to which access is controlled by one or more card readers.
 - 21. Secured side: Side of a security door where a higher security level needs to be granted for a user to be authorized to be in that side of the door.
 - 22. Serial line integration: A method to transfer information between two systems by means of an RS-232/RS-422 or RS-485 line, using ASCII strings.

- 23. Tamper: A condition within the circuitry of a monitored point which indicates the electrical integrity of that sensing circuit has been compromised.
- 24. Tamper proof screws: A screw with a security hexalobular internal driving feature as described in ISO 10664. As an example, a security TORX head, as developed by Camcar LLC.
- 25. Time Interval: A time stamp of one start time and one stop time within a time period.
- 26. Time Period: A user programmable period of time made up of days of the week and hours in the day.
- 27. Trouble: A condition within the circuitry of a monitored point which indicates that an equipment malfunction, single break, single fault or a wire-to-wire short exists.
- 28. Unsecured side: Side of a security door where a lower security level needs to be granted for a user to be authorized to be in that side of the door.
- 29. User Definable: An attribute of a security control system function that may be easily tailored by the System Administrator.
- 30. Workstation: A personal computer connected to the main security control system File Server via a local area network connection for the purpose of programming the system and responding to alarms.

1.8 SYSTEM DESCRIPTION

- A. The security systems primary purposes shall be to provide access control and alarm monitoring capabilities for this project. The system shall provide functionality such as the ability to regulate and control access through specific areas of the facility and fully integrate with other security components such as closed circuit television, alarm system, intercom and digital video recording.
- B. The system must utilize a single seamlessly integrated relational database for all functionality. This integration shall be provided using a single operating environment. The operating environment shall be the fully multi-tasking multi-threading operating system.
- C. Alarm monitoring and administrative workstations must be able to connect to, and monitor, field hardware devices such as card readers and intelligent system controllers. Administrative tasks including defining asset information, access groups, time zones, configuring digital video devices, generating reports, creating maps, etc. shall be provided from any client workstation on the network that is licensed to do so. All systems must utilize a single database on the network and must be accessible in real time to any security workstation connected to the network. This shall allow for automatic change propagation to all client workstations as well as common database consolidation.
- D. A real-time graphical map representing the layout of this building shall indicate if an electronically controlled door is in a secure or unsecured mode. Control modules will be required to lock, or unlock, any electronically controlled door or vehicle gate at this facility. An automatic cardholder call-up feature shall allow for the quick search and display of images in the database. A System's Operator journal shall be available to log important daily events. A trace function shall be available for System Operator's to locate and track activity on a specific cardholder or at a specific card reader. All system hardware must be controllable using a mouse to click on the associated system icon.
- E. The security system shall be designed to support an advanced distributed network architecture, whereas Intelligent System Controllers do not need to be home-run wired back to the database server. All Intelligent System Controllers shall be connected to an Ethernet network via industry standard TCP/IP communication protocol. Network based Intelligent System Controllers shall be able to communicate back with the database server through industry standard network switches and routers.

F. The security system shall support a data encryption utility. In utilizing encryption technologies, data communication shall be protected between workgroups, local area network computers, domain clients and servers, branch sites which may be physically remote, extranets, roving clients, and remote administration of computers.

PART 2 - SYSTEM CHARACTERISTICS

2.1 SECURITY SYSTEM SOFTWARE

- A. The SSI shall provide all software required for the complete operation of the access control system.
- B. Acceptable products for the security system software are:
 - 1. Honeywell Pro-Watch
- C. At a minimum the security system software shall provide the following key features:
 - 1. Ability to integrate with other system with features as indicated in this specification.
 - 2. Be able to operate with cards with multiple system codes.
 - 3. Have an integrated platform with the video system.
 - 4. Support browser based clients and standard client workstation.
 - 5. Ability to support mobile credentials
 - 6. Ability to integrate with visitor management system

2.2 COMPUTER SYSTEM HARDWARE

- A. Computer based system are required for the operation of the security system. The following types of computer systems are required for the system:
 - 1. Server: System that communicates with ISC and other hardware. It is also the system with the database of all the components and transactions of the system. Server shall be installed in a secured room.
 - 2. Workstation: System accessible to users for operating, configuring and accessing reports from the security system. Workstations communicate with the server through TCP/IP.
 - 3. Badging workstation: A system used to create the picture IDs for the system
- B. SOFTWARE ONLY. When the manufacturer of the Security System Software offers the possibility of providing the software only and the SSI is required to provide the hardware platform for the server the SSI shall provide a server in compliance with the Minimum Specifications by Software Manufacturer (MSSM) plus an extra capacity as indicated below:
 - 1. Processor speed: MSSM + 30%
 - 2. Cache memory: MSSM + 30%
 - 3. Front side bus speed: MSSM +30%
 - 4. Memory: MSSM + 100% (or maximum memory supported by Operating system)
 - 5. Hard drive capacity: MSSM + 100% in RAID 1 configuration
 - 6. CD/DVD Drive: DVD ROM Drive SATA, internal
 - 7. Network Card: Dual 1 GB connections
 - 8. Power supply: High Output Power Supply, Redundant.
 - 9. USB ports: Minimum six (6) USB 2.0
 - 10. Mounting: Rack chassis with sliding rapid/versa rails and cable management arm.
 - 11. Operating system: As required by security system software.
 - 12. Additional software: Database packages as required by Security System manufacturer. Antivirus and Internet Security package with a 1 year license
 - 13. Warranty: 3 –year warranty.

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

Project No. 121505 Electronic Security Systems Section 28 1000 - 6

- C. BROWSER BASED WORKSTATIONS. When the manufacturer of the security system offers browser based access to the security system, workstations will be provided by owner. Browser based workstations are only allowed in the system if they provide a complete functionality of the system. Browser based workstations are only be allowed additional to client based workstations.
- D. CLIENT BASED WORKSTATIONS. The SSI is required to provide the hardware platform for the workstation, the SSI shall provide workstations in compliance with the Minimum Specifications by Software Manufacturer (MSSM) plus an extra capacity as indicated below:
 - 1. Processor speed: MSSM + 30%
 - 2. Cache memory: MSSM + 30%
 - 3. Front side bus speed: MSSM +30%
 - 4. Memory: MSSM + 100% (or maximum memory supported by Operating system)
 - 5. Hard drive capacity: MSSM + 100%
 - 6. CD/DVD Drive: DVD ROM Drive SATA, internal
 - 7. Network Card: Single 1 GB connections
 - 8. Power supply: High Output Power Supply
 - 9. USB ports: Minimum six (6) USB 2.0
 - 10. Mounting: Desk mounted. If rack mounted is required a rack shelf shall be provided to mount the workstation
 - 11. Operating system: As required by security system software
 - 12. Additional software: Antivirus and Internet Security package with a 1 year license
 - 13. Warranty: 3 –year warranty.
- E. DESKTOP MONITORS: All workstations shall be provided with monitors. These monitors shall have the following specifications:
 - 1. Size: Minimum of 23" diagonal viewing size dimensions.
 - 2. Display type: LED
 - 3. Stand: 100 mm X 100 mm VESA mount adjustable height stand
 - 4. Display aspect ratio: 16:9
 - 5. Dot pitch: 0.248 mm
 - 6. Max resolution: 1920X1080 /60 Hz
 - 7. Color Support: 24 bit
 - 8. Response time: 5 ms
 - 9. Image Brightness: 250 cd/m2
 - 10. Image Contract ratio: 1000:1
 - 11. Signal input: DVI-D and VGA
 - 12. USB ports: Two (2) USB 2.0
 - 13. Speaker: Monitor shall be capable of mounting speakers in the bottom of the unit or in the side. Desk mounted speakers are not acceptable
 - 14. Energy Star compliant: yes.
 - 15. Power supply: 120 VAC
- F. RACK MOUNTED MONITORS: All monitors located in rack cabinets or consoles with rack rails for workstations or servers, shall have a VESA mounting bracket and a 19" rack mount adaptor. The adaptor shall allow the monitor to mount flush to the console or cabinet. If the monitor does not mount flush, then additional rack blank plates shall be provided to cover any exposed openings. Technical specs for desktop mounted monitors shall be followed.
- G. WALL OR CEILING MOUNTED MONITORS. When monitors are required to be installed in a wall or pending from ceiling in an area remote from the workstation, the following specifications shall be followed:
 - 1. General: The monitors shall have the following specifications:
 - a. Flat panel display format: 16:9.
 - b. Flat panel technology: LED

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 121505 Electronic Security Systems Section 28 1000 - 7

- c. Screen size diagonal: As indicated in design drawings ± 1 inch.
- d. Bezel: Bezel around screen shall be no bigger than 0.75"
- e. Brightness (cd/m2): 500
- f. Native resolution: 1920 X 1080
- g. Contrast ratio: 8000:1
- h. Refresh rate: 120 Hz.
- i. ATSC tuner included: No
- j. Speakers provided: Yes
- k. Video input ports: (2) HDMI, (1) RGBHV.
- I. Control ports: RS-232 in a DB9 connector.
- m. Warranty: Commercial grade unit with 3 years
- 2. Accessories: Mounts shall be provided with all displays. Design selection for the flat panel mount is Chief Manufacturing Company recommended mount for the display specified and the type of mounting selected in the design.
- 3. Transceivers: When the monitor is to be located more than 15 feet from the workstation, the SSI shall provide a pair of video transceiver systems using 4-pair UTP cable or fiber optics to send the signal to the monitor. The transceiver shall be selected as to properly operate at the designated distance from the workstation.
- 4. Accepted manufacturers: Mitsubishi, LG Electronics, Panasonic, NEC, Samsung, Sharp, Sony.
- H. REPORT PRINTER. The SSI shall provide report printers as indicated in the design drawings. The report printer shall be a color laser printer. The laser printer shall be capable of printing 17 ppm in color mode in paper formats up to 8.5"X14". The laser printer shall be provided with a network interface 10/100Base-T.
- I. KVM SLIDE TRAY. The KVM slide tray shall include a rack mounted monitor, keyboard and KVM switch. The unit shall have the following specifications:
 - 1. 1U Rack mount chassis
 - 2. 17" 1280X1024 TFT LCD panel
 - 3. On-screen controls
 - 4. Built-in keyboard and launch-pad mouse
 - 5. 8-port KVM switch (PS/2 or USB ports) with DVI-I inputs
 - 6. The unit shall be provided with all KVM cables with the correct mating connectors for all devices connected to the KVM switch.
 - 7. Design selection: Broadax Communication, Trip-lite, Avocent, etc.
- J. SYSTEM UPS. All workstation and servers shall receive a UPS system with an integrated surge protector. The UPS system shall be rated at 2200 VA. Minimum runtimes in the event of total power loss shall not be less than 15 minutes at full load.
- K. BADGE PRINTER: All photo identification workstations in the project shall include one badge printer. The badge printer shall have the following specifications:
 - 1. Printer type: Color dye sublimation or monochrome thermal transfer printing
 - 2. Printer speed: 225 card per hour, full color single sides.
 - 3. Resolution: 300 dpi
 - 4. Card type: PVC, PVC composite, adhesive backed
 - 5. Card width/length: CR-80, CR-79, ID-1 Format, ISO7810
 - 6. Card thickness: 10 mil. To 40 mil.
 - 7. Card feeder capacity: 100 cards (30 mil)
 - 8. Communications interface: Built-in 10/100Base-T.
 - 9. Accessories to be provided: Smart-card encoder-ISO 7816, ribbons and cleaning supplies to make 3,000 cards.
 - 10. Design selection: Zebra ZC350 or similar, with proven drivers to interface with access control software system.

- L. PHOTO ID CAMERA AND LIGHTING KIT. All photo identification workstations in the project shall include one photo-id camera and one lighting kit. The specifications of the photo-id camera are:
 - 1. CCD Sensor: ¹/₄" Sony interline CCD
 - 2. Active pixels: 1080P
 - 3. Sensitivity: 1 lux @ 30 IRE
 - 4. Signal to noise ratio: > 48 dB
 - 5. Gain: automatic or manual
 - 6. Lens: F1.4 to 2.8
 - 7. Zoom: Optical to 16X, Digital 128X
 - 8. Video output: USB 2.0
 - 9. Video capture: 15 fps @ maximum resolution.
 - 10. Accessories to be provided: synchronized cool white lights, telescoping stand, USB cable, and universal power supply and device drivers.

2.3 INTELLIGENT SYSTEM CONTROLLER (ISC)

- A. An Intelligent System Controller (ISC) shall link the security software to all other field hardware components like card readers, inputs and outputs. Controllers shall operate as autonomous, microprocessor based processing units:
 - 1. ISCs shall make decisions about access control, alarm monitoring, linking functions, and door-locking schedules for their operation, independent of other system components.
 - 2. ISCs shall be part of a fully distributed processing-control network.
 - 3. The portion of the database associated with a ISC, and consisting of parameters, constraints, and the latest value or status of points connected to that ISC, shall be maintained in the ISC.
- B. ISC can be one single hardware board or multiple hardware boards linked together. The following functions shall be fully implemented and operational within each ISC:
 - 1. Monitoring inputs (open, closed or fault).
 - 2. Controlling outputs.
 - 3. Automatically reporting alarms to the system server.
 - 4. Reporting of sensor and output status to the system server on request.
 - 5. Maintaining real time, automatically updated by the system server at least once a day.
 - 6. Communicating with the system server through a secured encrypted Ethernet TCP/IP communication.
 - 7. Communicating with other ISC or hardware devices through serial RS-422/RS-232/RS-45 encrypted lines.
 - 8. Executing ISC resident programs.
 - 9. Diagnosing.
 - 10. Downloading and uploading data to and from the system server.
- C. ISC Operations at a Location:
 - 1. Globally operating I/O linking and anti-passback functions between ISCs within the same location without system server or workstation intervention. Linking and anti-passback shall remain fully functional within the same Location even when the system server or workstations are off-line.
 - 2. In the event of communication failure between the system server and a Location, there shall be no degradation in operations at the ISCs at that Location. ISCs at each Location shall be connected to a memory buffer with a capacity to store up to 10,000 events; there shall be no loss of transactions in system history files until the buffer overflows.
 - 3. Buffered events shall be handled in a first-in-first-out mode of operation.
- D. Individual ISC Operation:

- 1. ISCs shall transmit alarms, status changes, and other data to the system server when communications circuits are operable. If communications are not available, ISCs shall function in a stand-alone mode; operational data, including the status and alarm data normally transmitted to the system server, shall be stored for later transmission to the system server. Storage capacity for the latest 1024 events shall be provided at each ISC.
- 2. Card-reader ports of an ISC shall be custom configurable for at least 120 different cardreader or keypad formats (Weigand). Multiple reader or keypad formats may be used simultaneously at different ISCs or within the same ISC.
- 3. ISCs shall provide a response to card readers or keypad entries in less than 0.25 seconds, regardless of system size.
- 4. ISCs that are reset, or powered up from a non-powered state, shall automatically request a parameter download and reboot to their proper working state. This shall happen without any operator intervention.
- 5. Initial Startup: When ISCs are brought on-line, database parameters shall be automatically downloaded to them. After initial download is completed, only database changes shall be downloaded to each ISC.
- 6. On failure for any reason, ISCs shall perform an orderly shutdown and force ISC outputs to a predetermined failure-mode state, consistent with the failure modes shown and the associated control device.
- 7. After power is restored, following a power failure, startup software shall initiate self-test diagnostic routines, after which ISCs shall resume normal operation.
- 8. After ISC failure, if the database and application software are no longer resident, ISCs shall not restart but shall remain in the failure mode until repaired. If database and application programs are resident, ISCs shall immediately resume operation. If not, software shall be restored automatically from the system server.
- E. Communications Monitoring:
 - 1. System shall monitor and report status of serial communications loop of each Location.
 - 2. Communication status window shall display which ISCs are currently communicating, a total count of missed polls since midnight, and which ISC last missed a poll.
 - 3. Communication status window shall show the type of CPU, the type of I/O board, and the amount of RAM for each ISC.
- F. Operating systems shall include a real-time clock function that maintains seconds, minutes, hours, day, date, and month. The real-time clock shall be automatically synchronized with the system server at least once a day to plus or minus 10 seconds. The time synchronization shall be automatic, without operator action and without requiring system shutdown.
- G. All ISCs shall be UL listed. Input points in ISCs shall be UL 294 listed.
- H. Basis of Design:
 - 1. System Controller: Mercury LP Intelligent Controllers
 - 2. Dual reader control module: Mercury MR SIO Series 3
 - 3. Sixteen (16) Input module: Mercury MR SIO Series 3
 - 4. Sixteen (16) Output module: Mercury MR SIO Series 3

2.4 POWER SUPPLY/ENCLOSURES – ACCESS CONTROL SYSTEM

A. All ISCs and other boards part of the access control system shall be installed inside a metal enclosure with a power supply as recommended and designed by the manufacturer of the equipment.

- B. The low voltage power supply shall convert a 115 VAC or 24 VAC 60 Hz input to a continuously supplied current of 12 or 24 VDC. The power supply shall be UL listed, fused protected and class 2 rated.
- C. The power supply shall include a battery charger to provide backup power when main power goes down. If ISC has a battery charger and input built in, then the power supply does not need this feature.
- D. Plug in transformers feeding a low voltage power supply feeding an access control panel are not allowed unless they are mounted inside another lockable enclosure. External multi-output individually fused protected outputs power supplies feeding all access control board are acceptable as long as they are located next to the access control panels.
- E. Maintenance free batteries shall be provided with all power supplies or ISC and shall be mounted inside the same enclosure. Batteries shall be sized to allow at least 4 hours of power backup. All power supplies shall be monitored for low battery through the access control system.
- F. All enclosures for ISCs, other electronic boards, power supplies or battery cabinets shall be UL listed NEMA 1 hinged cover enclosures where mounted indoors and in fully weatherproof NEMA 4X enclosures when located outdoors or in an exposed or covered area. All enclosure doors shall be key lockable, keyed alike, and shall include a tamper switch for monitoring by the security system. Any cabinet opening shall initiate an alarm condition to the security monitoring system.
- G. Basis of design: Altronix

2.5 TAMPER SWITCH

- A. All security enclosures, including power supplies and terminal cabinets shall include a tamper switch for direct supervision of the cabinet door. Any opening of these doors shall initiate an alarm condition to the security monitoring system. All tamper contacts shall be a reed actuated self adjusting plunger style switch. If a tamper contact is provided by the manufacturer with the enclosure this device may be used.
- B. Tamper switches shall be wired as to report separate alarms to the system for each panel.
- C. Basis of design: Amseco PSW-1 or an approved equal.

2.6 CONTACTLESS SMART CARD READER

A. The standard smart card reader for use throughout this facility shall be a switchplate style reader in low profile weatherized polycarbonate housing suitable for mounting in either an indoor or outdoor environment. The reader shall be constructed of a polycarbonate material sealed to a NEMA rating of 4X IP65. The reader shall contain an integral magnet for use with an external magnetic reed switch to provide tamper protection when connected to an external alarm. The reader shall be UL/C 294 listed and shall conform to FCC and ISO standards. The reader shall operate at a frequency of 13.56MHz 125KHz. All RF data transmitted between this device and the smart card shall be encrypted for additional protection using a secure algorithm. The reader shall provide an audiovisual indication to signify access granted or access denied. This operation shall be displayed by a high intensity LED light bar which shall change from red, amber, or green based on the status of the operation. The housing shall mount on an industry

standard single gang electrical junction box. It shall have a read range of 4.0 to 4.5 inches when used with a standard smart access card and 1.0 to 2.0 inches when used with a key tag.

- B. The mullion style readers shall only be used where wall mounting is not possible (for example glass/aluminum store-front systems).
- C. The smart card reader with keypad shall have a standard contactless smart card and shall have a twelve (12) key keypad. Readers with keypad shall be used where indicated in design drawings.
- D. With every badging station provided for this project, a verification reader with keypad shall be provided. This reader shall also have writing capabilities to the access cards. This reader shall be provided with USB interface and a stand for desktop mount.
- E. Communications between the readers and the ISC shall be through a OSDP interface, no exceptions allowed.
- F. Basis of design selection: HID Signo series.

2.7 CONTACTLESS SMART CARD

- A. The contactless smart cards for the access control system shall be receptive to a standard smart card reader. Body shielding or variable environmental conditions shall have no adverse effect on their operation.
- B. The following card quantities shall be provided for this project.

CARD TYPE	QTY
Keyfob	200
Single technology card for direct printing and thermal transfer	500

- C. All card ordered for this project shall have the same system code.
- D. All read/write cards ordered for this project shall have a 16K bit dual application area.
- E. All access cards or tags shall be purchased through the HID Corporate 1000 program with the facility code assigned to the owner.
- F. Basis of Design: HID SEOS

2.8 LONG RANGE UHF READER

A. The long range UHF reader to be used at the vehicle gates as indicated in the construction drawings. The reader shall be constructed of a polycarbonate material sealed to a NEMA rating of 4X IP65. The reader shall be UL/C 294 listed and shall conform to FCC and ISO standards. The reader shall operate in the 902-928 MHz UHF band to communicate with radio frequency tags and credentials. All RF data transmitted between this device and the credential shall be encrypted for additional protection using a secure algorithm. The reader shall have a read range of 15 feet when used with an approved credential.

- B. 12 VDC power for the long range reader shall be from a general use power supply with battery backup.
- C. The long range reader shall connect to a reader port on the ACS. The reader shall communicate to the ISC through Wiegand [OSDP] interface
- D. Basis of design: AWID LR-2000 or an approved equal.

2.9 LOCKING DEVICES – SPEICIFED UNDER DIV 8

A. The SSI shall coordinate with the door hardware installer on the placement of electronic locking hardware required for this project. The SSI shall provide all necessary wire and cable, and the low voltage power supplies for door locks. The SSI shall also be responsible for terminating all connections and interface this equipment with the integrated security system.

2.10 DOOR RELASE BUTTONS (REQUEST TO EXIT SWITCH/BUTTON)

- A. Where indicated on the drawings, a door release button shall be provided to function as a secondary method of door release on locked doors. The door release button shall have the following specifications:
 - 1. Button type: Illuminated.
 - 2. Button size: two inches square
 - 3. Lettering: "Push to Exit"
 - 4. Box size: Single gang
 - 5. Contacts: Momentary DPDT or (1 SPST N/O and 1 SPST N/C) 5A @ 30 VDC
 - 6. Built-in timer: Pneumatic timer, only required when used with electromagnetic locks.
 - 7. Finish: Bright Chrome
 - 8. Basis of design: RCI 991-PTD or equal.
- B. For applications where the door release buttons will be located under a desk a rocker switch shall be used instead of the regular exit device. The design selection for the rocker switch is the RCI 909 surface mounted.

2.11 REQUEST TO EXIT EGRESS MOTION SENSOR

- A. The egress sensors shall utilize passive infrared technology to detect the motion of individuals approaching a door. Upon activation this device shall release the lock, and shunt the magnetic door position switch to allow unobstructed egress through the door. This device shall be field adjustable to fit the monitoring requirements of the location where installed.
- B. All request to exit motion sensors shall be provided with a trim plate for mounting the detector over a standard single gang junction box.
- C. Basis of design: Detection Systems/Bosch model DS150i or an approved equal

2.12 MAGNETIC DOOR POSITION SWITCH – DPS

A. The standard recessed door position switch shall be Interlogix 1078 series or approved equal. The contact and the magnet shall be hermetically sealed in a one piece, molded, flame retardant ABS plastic housing for maximum strength and durability. The contact and magnet shall snap-lock into a predrilled 3/4" or 1" diameter hole. Color of the housing shall be off white, gray, or mahogany, and shall be provided in the appropriate color to match the door and doorframe. The magnet shall be made of Alnico V.

- B. The standard position switch for a roll up door shall be an Interlogix 2207AH high security contact or approved equal.
- C. On banks of doors where multiple doors are being monitored, door contacts shall be wired in series. All double doors shall receive (1) magnetic door position switch on each door leaf and shall report as one alarm point.
- D. On exterior doors with impact resistant listings, use only surface mounted door position switches in lieu of the standard recessed door position switches. The design selection is the Interlogix 1085T or approved equal.

2.13 DURESS PANIC BUTTON – UNDER DESK

- A. The unit shall consist of a housing that contains the electrical circuitry and magnetic reed contact, a cover plate to protect the internal electronics and actuating lever with an Alnico-V magnet installed in the cradle lever. The alarm shall occur when the actuating lever is moved 20 to 45 degrees past the fully closed position. The unit shall be mounted in specific locations of rooms indicated on the drawings. Obtain client approval on these locations prior to locating these devices.
- B. Basis of design: Interlogix 3040 series panic switch or an approved equal.

2.14 DURESS PANIC BUTTON- WALL MOUNTED

- A. The duress panic button wall mounted shall be a mushroom type button capable of fitting in a dual gang box with a single device adapter. The specifications of the duress panic button wall mounted are:
 - 1. Operation: push button once to engage, twist cap in direction of arrows to release.
 - 2. Plate construction: ¼" extruded aluminum plate
 - 3. Switch mode operation: latching maintained action.
 - 4. Switch configuration: SPDT
 - 5. Button finish: red cap.
 - 6. Screws: tamper resistant.
- B. Basis of design: Rutherford controls International model 919 or similar.

2.15 SURGE PROTECTION

- A. All security components mounted outside the building and wired through low voltage copper conductor back to the building shall be provided with surge and lighting protection. Provide UL listed multi-stage protection on all low voltage and signal transmission lines. All 120 VAC surge suppression devices shall be EDCO HSP121BT-1RU or an approved equal. For low voltage connections provide FAS-1 surge suppressors manufactured by EDCO or an approved equal. For RS-485 or RS-422 connections provide PC642C-008LC with base PCB1B manufactured by EDCO or an approved equal.
- B. For exposed Ethernet connections with PoE, use EDCO CAT6-E PoE or approved equal.

2.16 POWER SUPPLY – DOOR LOCKING HARDWARE AND SENSORS

- A. Power supplies for door locks or powered sensors (i.e. request to exit motion sensors) shall be completely separate from power supplies for ISC or electronic hardware part of the card access system.
- B. The power supply for door locks and powered sensors shall convert a 115 VAC 60 Hz input to a continuously supplied current of 24 VDC. The power supply shall be UL listed, NFPA compliant, and have multiple class 2 rated outputs. The power supply shall be housed in NEMA 1 hinged cover enclosures where mounted indoors and in fully weatherproof NEMA 4 enclosures when located outdoors or in an exposed or covered area. All enclosure doors shall be key lockable, keyed alike, and shall include a tamper switch for monitoring by the security system. Any cabinet opening shall initiate an alarm condition to the security monitoring system.
- C. The power supply for door locks and powered sensors shall include a battery charger and a battery input to provide power to the locks after a main power system failure. The switchover to stand-by battery shall be automatic when main AC power fails.
- D. Power supplies for regular locking hardware shall be installed next to access control panels.
- E. Maintenance free batteries shall be provided with all power supplies. Batteries shall be sized to allow at least 4 hours of power backup. All power supplies shall be monitored for low battery through the access control system.
- F. The power supply for door locks and powered sensors shall have the following features:
 - 1. Number of outputs: 16 programmable as fail-safe or fail secure individually
 - 2. Fire alarm disconnect: Yes, latching or unlatching and individually selectable for any of the inputs.
 - 3. Output protection: PTC
 - 4. Monitoring: AC fail and low battery with dry contact closure.
- G. Basis of design: Altronix Maximal series.

2.17 LOCAL ALARM

- A. The local alarm shall be a buzzer with strobe light that mounts in a double gang electrical box. The buzzer shall have an output capacity of 70 db @ 10 ft. from the source and. The strobe light shall radiate light at 75 cd.
- B. The local alarm shall be white and shall have no lettering.
- C. Basis of design: Gentex GEC3-12PWW or approved equal.

2.18 VEHICLE CARD READER, CAMERA, AND INTERCOM PEDESTAL

A. The custom pedestal shall be manufactured from 2-inch aluminum square tubing with a welded backplate and a square mounting baseplate with tapped holes. The stand shall include a fitted flange cover to conceal the mounting baseplate and associated fasteners required to secure this unit to the concrete platform. The enclosure shall be an aluminum design with a secure cover to prevent unauthorized access. This enclosure shall be weatherproof to protect electronics from environmental conditions. Dimensions and configuration of the pedestals shall be as indicated the design drawings.

2.19 KEY SWITCH

- A. The key switch shall be a capable of fitting in a dual gang box with a single device adapter. The specifications of the key switch are:
 - 1. Plate construction: 1/4" extruded aluminum plate
 - 2. Switch mode operation: maintained action.
 - 3. Switch configuration: one SPDT and one DPDT
 - 4. Cylinder: Match owner's keying standard.
 - 5. Screws: tamper resistant.
 - 6. LED: bi-color (red-green) mounted in plate.
 - 7. Design selection: Rutherford controls International model 960 or similar.

2.20 SLIDE GATE OPERATOR

- A. All slide gate operators for this project shall be provided under this scope of work. The placement of all gate controllers shall be coordinated with the locations shown civil and electrical documents. All gates shall be interfaced with the security system to restrict vehicle access into controlled areas.
- B. The slide gate controller shall be designed for high traffic use, commercial grade and continuous cycle operation with gates up to 1,500 pounds in weight and 45 feet in length. It shall use a solid steel machined pulley and notched v-grove belt for high efficient torque transfer from the motor to the gear reducer. The unit shall be suitable for Class I, II, III and IV applications.
- C. All control operations shall be provided through an advanced electronic control board that incorporates input and output control points on a solid state circuit board. Plug-in loop detectors shall be included for reverse detection.
- D. The slide gate operator shall utilize a 1HP instant reversing 115VAC 7 amp motor with a precision limit switch system. The slide gate operator shall be ETL listed or UL 325 and UL 991 listed.
- E. At a minimum each slide gate operator shall be provided with two (2) safety loops and sensors to prevent accidents.
- F. Basis of design: NKS DoorKing model 9150 or approved equal.

2.21 BARRIER GATE OPERATOR

- A. All barrier gates for this project shall be provided under this scope of work. The placement of all barrier gate controllers shall be coordinated with the locations shown civil and electrical documents.
- B. The gate arm shall be constructed of wood, plastic or aluminum. The gate arms shall be 14' in length or less depending on the size of the road. The gate arm shall be internally counterbalanced with 2 to 4 adjustable extension springs depending on the overall length of the gate arm. The barrier gates shall utilize loop detectors to prevent the gate from closing when a vehicle is located below the barrier arm. The gate shall also provide a means of sensing if the arm has encountered an obstruction during the up or down cycle. If an obstruction is encountered, the gate shall return to the beginning of the cycle, and wait five seconds before trying again.

- C. Non-directional vehicle loop sensors shall be used at the gates as shown on the contract drawings. The sensors shall detect the presence of a vehicle for gate opening during egress, and shall prevent the gate arm from closing on a vehicle while passing under an open gate. The detector shall resist lighting induced power surges on the detector loop by using a loop transformer between the loop and loop circuitry.
- D. The barrier gate operator shall use a 115 VAC power supply and shall have a •/2 HP continuous-duty motor. Only adjustments to the internal springs shall be required to compensate for gate arm of various lengths. The speed of the motor shall be adjustable by varying the voltage to the motor. All barrier gates must be grounded for protection from lighting strikes and power surges. The unit shall be suitable for Class I, II, III and IV applications
- E. The barrier gate operator shall be able to provide a dry-contact to the access control system indicating if the gate arm is in the up position (open contact) or in the down position (close contact). •The gate arm shall rotate 90° in approximately 1.5 seconds.
- F. Basis of design: DKS DoorKing 1601 with required accessories to achieve the described operation.

2.22 IMPACT SENSOR

- A. All slide gate operators shall be provided with a safety sensor to reverse the direction of the gate upon contact with an obstruction. The safety sensor for the sliding gates shall be a Miller-Edge model MU22 yellow color with XR5 chemical resistant cover.
- B. All safety sensors shall be interfaced with a safety edge transmitter which shall be the device which sends the signal to the gate operator when an obstruction is encountered. The safety edge transmitter shall be model MGT manufactured by Linear Access.

2.23 EXTERIOR EQUIPMENT HOUSING

- A. NEMA 4X rated stainless steel enclosures shall be provided to house electronic security equipment to all vehicle gates. The enclosure shall be constructed of 14 gauge stainless and shall have dimensions as required to hold electronics.
- B. All enclosures shall be provided with a pad lock and a tamper switch for direct supervision. Any door opening shall initiate an alarm condition to the security monitoring system. All cores shall be keyed alike. A grounding package shall be provided for connection to a ground rod. A #8 solid copper ground wire shall be provided and installed from the ground lug to a grounding rod installed next to the enclosure.
- C. All exterior enclosures shall include a compact air condition unit. The air condition unit shall be as indicated in the design drawings. All air condition units shall be monitored for proper operation through relay contacts through the access control system.
- D. Basis of design: nVent Watershed, Type 4X

2.24 LOOP DETECTORS

- A. Loop detectors shall be used to detect the presence of a vehicle in the spot where the loop detector is installed. Loop detectors shall be used as indicated in the design drawings to control gates, or to notify the presence of a vehicle in a specific area.
- B. The loop detector system shall have the following specification:
 - 1. The unit shall have loop diagnostics, a loop isolation transformer and loop conditioner.
 - 2. The unit shall have aluminum RF shield housing, surge protection and a loop frequency counter.
 - 3. The unit shall have sensitivity controls (10 levels), function controls and operation controls, through dip switch settings.
 - 4. Unit shall operate at 12 V AC/DC or 24 V AC/DC.
 - 5. Unit shall have at least two outputs on SPDT contacts.
- C. The size of the loop shall be as recommended by gate ISC manufacturer. The SSI shall estimate the number on turns to ensure a maximum detection height of 3.2 ft from the ground.
- D. After the wire loop is installed the SSI shall seal the opening only with a commercial type loop sealant designed for traffic loops. The SSI shall install wire loops with backer rod to prevent the wire from moving. For sealants and baker rods use RAI products or similar manufacturer.
- E. Loop detectors shall be installed inside a metal enclosure in the secure side of the gate. Loop detector can be installed inside the enclosure for the gate operator or in a separate Stainless Steel NEMA 4X enclosure sized for the dimensions of the devices.
- F. Power for the loop detectors shall be provided from the gate operator or from a power supply located in the telecommunications closet, when the loop is not part of the gate safety or request to exit features.
- G. Basis of design: D-Tek loop detector by EMX industries or recommended device by manufacturer of gate operator.

2.25 DIN-RAIL MOUNTED RELAYS

- A. General Description: Any time the access control system needs to switch any load that is not considered a Class 2 circuit as defined in the NEC article 725, or any load that works at voltages higher than 24 V (AC or DC) an external relay shall be used to switch the load. The Access control relay from an RIM or and OCM shall drive the coil of the external relay which contacts shall control the load. These additional relays shall always be mounted in a DIN rail and will be references in this specification as the DIN-rail mounted relays. These DIN rail mounted relays shall have the following specifications:
 - 1. Number of contacts: 2 –Poles
 - 2. Contact type: Form C
 - 3. Contact material: AgCdO (silver tin oxide) or Gold plating
 - 4. Contact rating: 8 A minimum or as required by load
 - 5. Insulation voltage: 250V IEC, 300V UL
 - 6. Coil voltages: 24 VDC
 - 7. Enclosure design: Slim line design. Width less than 0.5"
- B. All DIN rail mounted relays shall be provided with a base made of molded high dielectric material, with terminal screw sockets for all contacts. All bases shall be capable of mounting on a standard DIN (#3) 35 mm wide rail and shall be of the screw terminal type.

- C. All DIN rail mounted relays shall be provided with end clamps at the ends of each row of devices and shall be mounted inside security enclosures.
- D. Basis of design: Rockwell Automation series 700-HK or equal.

2.26 DIN-RAIL MOUNTED TERMINAL BLOCKS

- A. General Description: When multiple terminations are required for cabling part of the security system separate from the termination blocks mounted on the access control equipment, DIN rail mounted terminal blocks shall be used to make all wire termination. Other termination methods such as wire nuts, crimp on connectors, shall not be used. The specifications of the DIN rail mounted terminal blocks are:
 - 1. Block type: Feed-through block, for single conductor or two conductors, modular system. SSI to select according to application. Block shall be specifically designed for mounting on a DIN rail. Other types of blocks designed for direct surface mounting on a panel are not allowed.
 - 2. Termination type: Captive screw connection.
 - 3. Wire range per contact: AWG 28 to AWG 12
 - 4. Maximum voltage rating: > 600V AC/DC
 - 5. Maximum current rating: >20 A
 - 6. Size: Termination block shall separate termination point from enclosure back panel no less than 0.5"
- B. DIN rail mounted termination blocks shall be provided with all accessories including: DIN rail, end barriers, end anchors and jumpers.
- C. Basis of design: Allen-Bradley 1492 series blocks, or similar from Eaton or Phoenix Contact.

2.27 WIRE & CABLE

- A. Cables for un-powered security sensors shall have the following specification:
 - 1. Minimum cable gauge: AWG 20
 - 2. Number of conductors: 2, stranded conductors
 - 3. Conductor type: Bare copper
 - 4. Cable insulation: Color coded PVC
 - 5. Conductor insulation colors: Black and red.
 - 6. Voltage rating: 300V
 - 7. Cable shield: No cable shields
- B. Cables for powered security sensors shall have the following specifications:
 - 1. Minimum cable gauge: AWG 20
 - 2. Number of conductors: 4, stranded conductors
 - 3. Conductor type: Bare copper
 - 4. Cable insulation: Color coded PVC
 - 5. Conductor insulation colors: Black, red, white and green.
 - 6. Voltage rating: 300V
 - 7. Cable shield: No cable shields
- C. Cables for access control readers shall have the following specifications:
 - 1. Minimum cable gauge: AWG 22
 - 2. Number of conductors: 6, stranded conductors
 - 3. Conductor type: Tinned copper
 - 4. Cable insulation: Color coded PVC

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 121505 Electronic Security Systems Section 28 1000 - 19

- 5. Conductor insulation colors: Black, red, white, green, orange (or brown) and blue.
- 6. Voltage rating: 300V
- 7. Cable shield: Aluminum/polyester foil (overall) with a AWG 24 tinned copper drain wire
- D. Cables for RS-232, RS-422 or RS-485 control lines shall have the following specifications:
 - 1. Minimum cable gauge: AWG 24
 - 2. Number of conductors: 2-paired, stranded conductors
 - 3. Conductor type: Tinned copper
 - 4. Cable insulation: Polyethylene
 - 5. Conductor insulation colors: White-blue, blue-white white-orange and orange-white
 - 6. Voltage rating: 300V
 - 7. Cable shield: Aluminum/polyester foil (overall), a tinned copper braid (90% coverage) and a AWG 24 tinned copper drain wire
 - 8. Nominal characteristic impedance: 120 Ohms
 - 9. Nominal capacitance: 12.8 pF/ft.
 - 10. Nominal delay: 1.6 ns/ft.
 - 11. Nominal attenuation: 0.6 dB/100 ft @ 1 MHz.
- E. Cables for door locks and low voltage power supplies shall have the following specifications:
 - 1. Minimum cable gauge: AWG 18
 - 2. Number of conductors: 2, stranded conductors
 - 3. Conductor type: Bare copper
 - 4. Cable insulation: PVC
 - 5. Conductor insulation colors: Black and red.
 - 6. Voltage rating: 300V
 - 7. Cable shield: No cable shields
- F. Cables for loop detectors shall have the following specifications:
 - 1. Minimum cable gauge: AWG 16
 - 2. Number of conductors: 1, stranded conductors
 - 3. Conductor type: Bare copper
 - 4. Cable insulation: Cross-linked polyethylene (XLPE)
 - 5. Conductor insulation colors: Black
 - 6. Voltage rating: 600V
 - 7. Cable shield: No cable shields
- G. All UTP Category horizontal cables and fiber optic cables for the security system shall be in compliance of all requirements in specification section 271000 and shall be under the same warranty as all UTP category cables and fiber optic cables described in specification section 271000.
- H. Cable gauge: All cable gauges shall be estimated as to allow a maximum of 5% voltage drop from the source to the load. Sizes given previously are only minimum gauges accepted. The SSI shall always estimate proper values.
- I. Cable jackets: All cable jackets shall be suitable for the environment on which the cables will be installed. Use plenum rated cables when cables are installed in plenum spaces. Use riser rated cables when cables are installed through floor sleeves. Use cable jackets with water-blocking material when installed in underground conduits. All cables with a NEC type TC shall be run fully in conduit from the panel to the device and shall be separated from other communication or Class 2 rated cables.
- J. Cable jackets for this project: Except when cables are run continuously in conduit all cable jackets for access control cables shall be plenum rated.

- K. All cables shall be RoHS compliant and free of VOC. The SSI shall provide proof of compliance for all cables during the submittal process.
- L. Acceptable manufacturers: Belden, Alpha Wire Company, General Cable and West Penn Wire.

2.28 IDENTIFICATION AND LABELING TAGS

A. The SSI shall follow labeling materials indicated in specification section 270010

PART 3 - EXECUTION

3.1 SECURITY DOORS FUNCTIONALITY

A. SSI shall fully review and understand the functionality of each electronically locked door as specified in the Division 8 door hardware specifications. All control logic for this functionality shall be accomplished through local input/output events. Global events to accomplish these requirements are not allowed. Failure of the access control server shall not limit the functionality of the doors. When the word reader is used, it means it is a generic device, it could be any type of reader (biometric, iClass, prox) with or without keypad, see the design drawings for particular selection for every door.

3.2 SECURITY SYSTEM INTEGRATION

A. General: A. The access control system software shall integrate with the other security system components as indicated in this section. The SSI shall be responsible for programming all security systems in such a way that interaction between the different systems is achieved to provide a higher degree of security in the building. The minimum required integration features between the access control and the other security systems are described below:

B. ACCESS CONTROL AND DIGITAL VIDEO RECORDING SYSTEM

- 1. The Access control software proposed shall integrate with the new Digital Video Recording System (DVRS) proposed for this project (refer to specification section 282000 for details on the Digital Video Recording System). The integration shall make the following features possible from the Access Control GUI:
 - a. Event video tagging. Selectable security events in the access control system shall tag the recorded video, so when the operator reviews the event, video from that moment in time when the event took place shall be retrieved automatically and brought into a window of the access control GUI.
 - b. DVRS playback control: Through the access control GUI, the operator shall be capable of controlling the video playback. The operator shall be capable of retrieving any recorded video from any camera by using a time search or an event search. The operator shall be capable of controlling the speed of the playback by selecting frame by frame playback or playback at higher speeds.
 - c. Live video: The operator shall be capable of displaying live video in window in the access control GUI. The operator shall be capable of selecting the camera in the system that he/she wants to see. Up to 4 live video windows (live or recorded) shall be possible in every workstation running the access control GUI.
 - d. PTZ Control: The operator shall be capable of controlling all PTZ features of a camera by simply using buttons in the Access Control screen with the orientation of movement.
- e. Alarm event: Any alarm event (like video analytic alarms, or video motion detection) in the DVRS shall be transferred to the access control system for processing as any other alarm in the access control system. Alarms shall be uniquely identified in the access control system.
- f. Status events: Any status events (system errors, or administration events) in the DVRS shall be transferred to the access control system for processing as any other status event in the access control system. Events shall be uniquely identified in the access control system.
- g. Export/load video file: the operator shall be able to export or load video files compatible with the recording format of the DVRS from the access control GUI.
- h. Recorder authentication: Since login is required for most DVRS, the login action on the Access Control System shall also grant access to the DVRS. Separate or further login to the DVRS shall not be required.
- i. Dry contact control: The operator shall be capable of triggering relay contacts part of the DVRS equipment from the access control GUI.
- j. Video locking: The operator shall be capable of locking video on the DVRS to prevent it from being purged accidentally. Locked video can be set to automatically purge or archive based on user defined thresholds.

C. CCTV SYSTEM

- 1. Activation of access control system alarms (like door held open, door forced open, stolen/lost card used, duress alarm, alarms coming from other systems, etc) shall call presets in the nearest CCTV cameras (one or more) to point towards the device that is in alarm. This action shall take place without any operator's intervention.
- 2. Activation of access control system alarms shall call any associated camera to the triggered alarm to the operator's workstation alarm monitor. This action shall take place without any operator's intervention. When the alarm is cleared by the operator the image of the alarm monitor shall be removed. Alarms from doors in detention areas shall be received in the monitors in Master Control Room, alarms from doors in other areas shall be received in Building control room.
- 3. Video loss alarm: loos of video signal on any of the surveillance cameras in the system shall trigger an alarm in the access control system.
- 4. Graphic substation calling: Intercom substations shall be represented with graphic icons in the graphic maps part of the Access control system GUI. Double clicking on those icons shall automatically create a call to that substation from the master station associated with the user workstation initiating the command.
- 5. Graphic camera calling: Surveillance cameras shall be represented with graphic icons in the graphic maps part of the Access control system GUI. Double clicking on those icons shall automatically open a video window with a live stream from that camera.

D. INTERCOM SYSTEM

- Alarm event: Activation of an intercom substation (or emergency call assistance station) shall be treated as an access control alarm event, calling camera presets and calling any associated cameras to the operator's alarm monitors. This action shall take place without any operator's intervention. Substations in detention areas shall generate those alarms in Master Control room while substations in building exterior or elevators (except the prisoner elevator) shall generate those alarms in Building control room.
- 2. Automatic call: Alarms from doors with intercom substations installed by the door shall generate an automatic call to the master station in the monitoring rooms from the substation. The call shall be placed to the same master station that the substation is programmed to call when user pushes the call button.
- 3. Remote door release: During a call from a substation by an access controlled door to a master station, the user in the master station side shall be capable of opening the door by pressing a key in the mater station keypad. This action shall not create any alarm conditions in the access control system.

- 4. Graphic substation calling: Intercom substations shall be represented with graphic icons in the graphic maps part of the access control system GUI. Double clicking on those icons shall automatically create a call to that substation from the master station associated with the user workstation initiating the command.
- 5. Graphic status: intercom substations in use in the system shall be represented with a different color (red) from stations not used (green) in the graphic maps part of the access control system GUI.

E. LOCKDOWN FEATURES

1. Graphical user interface shall have buttons for enabling lockdown of specific areas based on the operational use cases presented by the Owner to the SSI during the programming phase.

F. DOOR ENTRY SYSTEM

- 1. Remote door release: During a call from a substation by an access controlled door to a master station, the user in the master station side shall be capable of opening the door by pressing a key in the mater station keypad. This action shall not create any alarm conditions in the access control system.
- G. ALARM SYSTEM.
 - 1. Alarm events: Activation of a device in the alarm system shall be treated as an access control alarm event, calling camera presets, calling any associated cameras to the operator's alarm monitors and creating automatic intercom calls (if available). This action shall take place without any operator's intervention.
 - 2. Status events: Status alarm conditions (faults or errors) shall be reported to the access control system with unique identifiers.
 - 3. Graphic status: All alarm devices shall be represented with graphic icons in the graphic maps part of the access control system GUI. Alarm devices shall represent their status with a different color, red for "on alarm" condition, and green for "no alarm" condition in the graphic maps.
- H. Different methods of integration are allowed between the access control system and the other systems. Integration methods are given different hierarchy as follows, relay integration is lowest hierarchy, serial line integration is considered medium hierarchy integration and API integration is considered high hierarchy integration. At a minimum integration between the different security system shall be provided with the integration method explained below. It is acceptable for the SSI to propose integration methods with higher hierarchy integration methods, but not with lower hierarchy methods. The requested integration methods with each system are as follows:
 - 1. Access control system and DVRS API integration.
 - 2. Access control system and CCTV system API integration.
 - 3. Access control system and Intercom system API integration.
 - 4. Access control and door entry system Relay integration
 - 5. Access control and Alarm system API integration
 - 6. Access control and Detention system Relay integration
 - 7. Access control and Paging system Serial line integration or API.
 - 8. Access control and AV system Serial line integration or API.

3.3 INSTALLATION PRACTICES

- A. General: The SSI shall follow all installation practices indicated in specification section 270010.
- B. Access control panels and multi-output power supplies shall be installed as to have in any cluster of panels no less than 2 spare ports (reader ports for access control) available per cluster of panels.

- C. All power supplies shall be monitored for AC failure. When power supply provides a form c relay with low battery signaling, this contact shall also be monitored. All AC fail and battery low alarms shall be monitored through individual alarm inputs. Series connections of multiple alarm points shall not be allowed.
- D. All buzzers inside card readers shall be wired as to function to alert users of different door status like (door held open alarm and door forced open alarm).
- E. All local alarms shall be wired with separate wires for the buzzer and for the strobe, so independent use of the strobe and buzzer can be selected by the user.

3.4 WIRING METHODS

- A. All proposed wire and cable shall meet or exceed the recommendations established by the equipment manufacturers, and shall comply with all state and local codes.
- B. Visually inspect all wire and cable for faulty insulation prior to installation. Protect cable ends at all times with acceptable end caps.
- C. Provide grommets and strain relief materials where necessary to avoid abrasion and excess tension on wire and cable.
- D. All termination of UTP Category type multi pair cables shall be done in Insulation Displacement Connectors (IDC), modular plugs or connectors. The use of wire nuts or manually twisting cables and protecting them with electrical tape are not acceptable means of termination.
- E. All cable with gauges larger or equal to AWG-18 and all types of stranded conductors shall be terminated on termination blocks part of an active equipment or in termination blocks supplied by the SSI. The use of wire nuts or manually twisting cables and protecting them with electrical tape are not acceptable means of termination.
- F. All termination blocks shall always be mount inside a security enclosure, with a hinged cover and lock. Up to 2 conductors can be terminated in the same point in a termination block as long as the combined diameter of the conductors does not exceed the maximum cable diameter allowed by the termination block. No more than 2 conductors shall be terminated in the same point at a termination block regardless of the cable gauges.
- G. Termination blocks shall be used for wire terminations next to access control panels or for termination above the security doors. Termination blocks are not required for connection to security devices at the door side.
- H. When equipment supplied has wire leads instead of termination en points for connections, the only acceptable methods of connection to field wiring are insulated butt splices, quick release connectors (both ends provided) or quick lock self stripping pig tail connectors. All connectors or splices shall be selected according to the gauge of the cable to be terminated.
- I. All penetrations through fire rated barriers shall be provided, by the SSI, with appropriate fire stopping materials in accordance with NFPA requirements and local fire authority having jurisdiction.
- J. All cable runs shall be continuous from the device to the equipment. Cable splices shall not be allowed inside conduits, or cable trays.

- K. Cables of similar signal level shall be bundled together and kept physically separate from power cords, plug strips or other circuits with different potential. Exposed wire bundles or individual cables shall be neatly secured with self-clinching nylon "TY-Raps" (Thomas & Betts or equal).
- L. All cables run part of the security system in areas where ceiling is not accessible or in building exterior shall be in conduit at all times.
- M. All cables for security equipment shall be installed in conduit to the nearest accessible ceiling space, J-hook to the cable tray and from the cable tray and from the tray to the equipment cabinets. The SSI shall provide all j-hooks to support the cables part of these components.
- N. Components of the distribution system shall be installed in a neat, workmanlike manner consistent with all best practices.
- O. Wiring color codes shall be strictly observed and terminations shall be uniform throughout the building.
- P. Finger duct wire managers shall be used inside all equipment panels to properly dress cables.

3.5 IDENTIFICATION AND TAGGING

- A. All cables, wires, wiring forms, terminal blocks, and terminals shall be clearly identified by preprinted labels or tags. The permanent markings shall clearly indicate the function, source, and destination of all cabling, wire, and terminals. All cables shall be labeled at both ends of the cable with the same and unique identifier label.
- B. Cable and equipment identifiers shall follow a standard labeling system like TIA/EIA-606. The identification system chosen by the SSI shall be submitted for approval to the A&E.
- C. All access control panels, alarm panels, PLCs, or Intercom exchanges shall include a work sheet attached to the interior of the panel/ equipment in plastic envelops. This work sheet shall include the location, type of device and part number of all devices connected to the boards inside those equipments. All names used to identify devices in these worksheets shall match all names and identifiers used in the software or the user interface of the system. A second copy of this worksheet shall be delivered to as part of the as-built information.

3.6 SECURITY SYSTEM PROGRAMMING

- A. Programming: It is the responsibility of the SSI to program all requested features in the access control system and the integration to other security systems. The programming responsibilities of the SSI include but not limited to:
 - 1. Program all security doors to achieve the desired operation as described in this specification section. The SSI shall coordinate with the owner the door names and numbers, building names, room names and numbers to be used for the programming.
 - 2. Program all components of the system to achieve the functionality described in this specification.
 - 3. Program at least 15 access profiles for card holders and all access profiles for doors.
 - 4. Create at least 5 administrator profiles. The owner will program any additional card holder profiles required in the system.
 - 5. Program at least five hundred (500) users in the system. The SSI shall get this information from the owner. The owner will program all other users in the system.

- 6. Program all required security features like macros and integration with other security modules like intercom and CCTV system.
- 7. Program all interfaces with the elevator control systems.
- 8. Program all GUIs in the system. The SSI shall use Autocad drawings to create all maps of the facility with the corresponding icons for control, operation and visualization of the security system. The SSI shall chose a scale for the drawings that allows all icons to be places without overlap and close enough to the actual physical location of the equipment in the map as to avoid ambiguity of the actual location of the devices. Nested maps shall be programmed to go from a complete building view to a detail zoned identifying all devices in the area.
- 9. The SSI shall coordinate with the owner what alarms from the access control system are to be considered major alarms. All major alarms shall be programmed by the SSI to provide the operator detail information on the type of operating procedure expected during those alarms. All mayor alarms shall be programmed as to provide the operator and input field to type the response taken by the operator.
- 10. All programming of remote monitoring features for the security system like telephone numbers to dial, reporting codes and alarm formats.
- 11. All alarm messages and descriptive text of those messages shall be programmed.
- 12. Program lockdown areas
- B. DOOR INTERLOCKS: When indicated in the drawings (or in the sally port) two doors that have a controlled door interlocks, the SSI shall program the security system as to provide the following functionality: While one door is opened the other door shall not be possible to be opened not by using a valid transaction at the reader neither by issuing a remote release command from the access control system.
- C. The SSI shall conduct at least four (4) 4-hour meetings to discover, document and review the Owner's programming requirements for the system. The SSI shall work with the owner during the programming of the system to fine tune all programming requirements of the system, as per owner's request. Fine tune is defined for this purpose as changing all field parameters available in the system, as specified, to complete software options available in the system. Fine tuning does not indicate adding additional software modules or additional hardware.

3.7 ADDITIONAL INSTALLER RESPONSIBILITIES

- A. Upon project commencement, the SSI shall provide qualified technical personnel on-site. Personnel shall be present on each consecutive working day until the system is fully functional and ready to begin the testing phase of this project.
- B. During the installation process the SSI shall maintain an up-to-date set of as-built shop drawings, which shall always be available for review by the client and/or consulting engineers. This set of documents should be clearly annotated with as-built data as the work is performed. These documents will be reviewed as part of the approval process when evaluating payment request applications. At a minimum, the drawings should contain the following information:
 - 1. Quantity and location of all equipment installed.
 - 2. Cable and wire runs along with the designations tags assigned to each.
 - 3. Wiring diagrams that indicate terminal strip layout, identification, and terminations.
- C. The SSI Project Manager shall maintain continuous coordination with the A&E. The A&E shall be kept informed of the progress and all conflicts that arise during the course of this project. Prior to the start of construction the SSI shall submit a complete plan and schedule for proposed operations. This schedule should include information relevant to number of employees assigned to the project, work hours, etc.

3.8 REQUEST OF IP ADRESSES

A. The SSI shall comply with all requirements indicated in specification section 270010 for requesting IP address for the security system.

3.9 SYSTEM WARRANTY AND SERVICE

A. General: The SSI shall follow all warranty and service requirements indicated in specification section 270010.

3.10 ENGINEER'S FINAL ACCEPTANCE TEST

- A. General: The SSI shall follow all test requirements indicated in specification section 270010.
- B. Additional requirements for the system acceptance test:
 - 1. The day of the final acceptance test the SSI shall have at least two (2) 2-way radios to communicate between the testing groups. Cell phones are not acceptable for communication since it takes too long to establish communication, and will delay the test substantially. Radios shall be fully charged, and spare batteries shall be available for 8 hours of use.
 - 2. The final acceptance test will be done with two groups of people. Each group will have at least one member of each stakeholder of the project (A&E, Owner, SSI, General Installer/ Construction Manager). One group will be station in the monitoring room the other group will be going to all locations in the project where security equipment is installed.
 - 3. During the final acceptance test every single device in the security system will be tested for normal operation and for simulated alarm conditions at both ends (the field devices and in the monitoring room). When possible, security equipment will be tested for operation during main power failure. All features requested in this specification will be tested.
- C. Testing of all structured cabling system part of the Security System shall be done in accordance of specification section 271000

3.11 SPARE PARTS

- A. As part of this project the SSI shall provide the following spare parts:
 - 1. One (1) Intelligent System ISC (ISC)
 - 2. One (1) Standard card readers
 - 3. One (1) Card reader with a keypad
 - 4. Two (2%) percent of all installed field devices, like local alarms, duress buttons, door position switches, tamper switches, request to exit motion sensors, etc. Minimum of one (1) each.
 - 5. One (1) Power supply for locks
 - 6. One (1) power supplies for access control panels.
 - 7. Four (4) surge protection devices of each type used in the project.
- B. A list of delivered spare parts shall be included with the close out information. This list shall indicate all components delivered and shall be signed received by the Owner. The name of person receiving the equipment shall be clearly written in the list and the date it was received.

3.12 TRAINING AND INSTRUCTION

- A. General: The SSI shall follow all training requirements indicated in specification section 270010.
- B. The SSI shall provide three (3) levels of training for this project as explained in this section.
- C. USER TRAINING.
 - 1. User training shall be provided for security personnel interacting with the security system in areas different from the security monitoring rooms. The purpose of this training is to explain clearly how the field devices operate and what the different status indicators mean.
 - 2. This training shall cover operation of devices and doors like:
 - a. Operation and indication of all types of readers in the project
 - b. Operation of all roll-up doors.
 - c. Operation of all vehicular gates.
 - d. Resetting door alarms (local) for all door types.
 - e. Resetting of duress alarm buttons.
 - f. Operation of door interlocks
 - g. Operation of the duress alarm notification system
 - 3. This training shall be provided by personnel working directly for the SSI.
 - 4. At least 4 separate sessions (on 4 different days) of this type of training shall be provided (one session video-taped only).
 - 5. Each session could have up to 20 trainees.
 - 6. No training material is expected to be provided
- D. OPERATOR/ADMINISTRATION TRAINING.
 - 1. Operator/Administration training shall be provided for security and IT personnel interacting with the security system in all security monitoring rooms. The purpose of this training is to explain clearly how the complete system operates and what the different status indicators mean.
 - 2. This training shall cover at least the following topics:
 - a. All content provided during the user training.
 - b. Operation of the Access control software (all aspects).
 - c. Operation of all devices inside the security monitoring room.
 - d. Alarm response and alarm reset in the security monitoring room
 - e. Data backup/restore and achieving.
 - f. File import/export.
 - g. Badging system operation (complete description)
 - h. Creating reports and print outs.
 - i. Basic system troubleshooting.
 - j. Creating users and password reset.
 - 3. This training shall be provided by personnel working directly for the SSI or a direct employee of the manufacturer of the system.
 - 4. One session of this type of training shall be provided and video-taped. This session shall last no less than 24 hours, broken down into day sessions no longer than 6 hours each.
 - 5. Each session could have up to 20 trainees.
 - 6. The approved O&M manuals shall be available at the time of the training.
- E. MAINTENANCE TRAINING.
 - 1. Maintenance training shall be provided for maintenance and IT personnel. The purpose of this training is to explain how to troubleshoot and replace all field devices and hardware.
 - 2. This training shall cover at least the following topics:
 - a. Trouble shooting and replacement of all field devices.
 - b. Installation of all field panels and settings (jumpers, dip switches, etc).

TLC Engineering Solutions

Project No. 121505 Electronic Security Systems Section 28 1000 - 28

- c. Wire labeling system.
- d. Software system installation and recover from system crashes.
- e. Detail explanation on all physical keys used in security devices.
- f. Routine preventive maintenance procedures recommended by equipment manufacturers for all components of the system.
- g. Detail explanation of source code programming for all devices that have software code specifically compiled for this project.
- 3. This training shall be provided by personnel working directly for the SSI or a direct employee of the manufacturer of the system.
- 4. One session of this type of training shall be provided and video-taped. This session shall last no less than 18 hours, broken down into day sessions no longer than 6 hours each.
- 5. Each session could have up to 5 trainees.
- 6. The approved O&M manuals shall be available at the time of the training.

3.13 AS-BUILT DOCUMENTS AND CLOSE OUT INFORMATION.

- A. General: The SSI shall follow all as built and close out information requirements indicated in specification section 270010
- B. Additional requirements for as-built documentation shall include:
 - 1. Approved as-built drawings shall be a complete set of floor plans drawings, riser diagrams, and wiring details indicating the layout and interconnection of the system. All cable routings and elevation of each outlet, tie, and riser cable terminations shall be required.
 - 2. The content of the as-built information shall be no less than the content provided during the shop drawings, and shall be modified as per changes done during construction.
- C. Close out information shall also include:
 - 1. Two (2) digital backups of all configuration files and databases part of the security system not earlier than the day after the final acceptance test is approved. These backups shall include a list of all the file names used and a complete description of the system that each file name belong to. The media for these backups shall be a compatible media that can be read by the computer system running the specific software program.
 - 2. Testing reports for structured cabling system used for the Security system.

END OF SECTION 281000

SECTION 28 1010 INTRUSION DETECTION SYSTEMS

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. The scope of work shall include furnishing all labor, materials, enclosures, wiring, equipment, and documentation required to provide a completely operational and working Intrusion Detection System (IDS).
- B. The Intrusion Detection System Installer (IDSI) shall coordinate with other trades such as security system, CCTV, electrical system installer, the door frame installer, the door installer and the door hardware installer for all parts of this scope of work.
- C. All materials and installation labor for structured wiring system (4-pair UTP cables, fiber optic cables and 24-AWG multi-pair (25 pairs or higher) backbone cables) components required for the intrusion detection system shall be in compliance with specification section 271000.

1.2 RELATED DOCUMENTS

- A. General Terms and Conditions of the Contract Documents
 - 1. Division 26 Electrical
- B. Supplemental: Refer to the specification sections identified below for additional requirements, which are supplemented by this section.
 - SECTION TITLE
 - 27 00 10 Technology General Provisions
 - 27 05 28 Raceways for Technology
 - 27 10 00 Structured Cabling System
 - 27 05 26 Grounding & Bonding for Telecommunications Systems
 - 28 10 00 Electronic Security Systems
 - 28 20 00 Closed Circuit Television System

1.3 INTRUSION DETECTION SYSTEM INSTALER QUALIFICATIONS

- A. The IDSI selected for this project must be a direct manufacturer authorized representative of the product they propose to provide. All technicians assigned to install and configure this system shall be factory trained and certified for the proper installation of this equipment. The IDSI must have a minimum of 5 qualified and factory trained technicians to support this system. This company must be of established reputation and experience, regularly engaged in the supply and support of such systems for a period of at least five consecutive years under the current company name.
- B. Other required IDSI qualifications are:
 - 1. The IDSI selected for this project must be an authorized reseller of the basis of design product systems.
 - 2. The IDSI shall agree, in writing, as part of their proposal, to provide both warranty and non-warranty service within 4 hours of notification of a problem. The IDSI shall be able to perform any and all repairs to the system within 24 hours.
 - 3. The IDSI, as a minimum, must carry a current state issued limited energy license.

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 121505 Intrusion Detection Systems Section 28 1010 - 1

1.4 MATERIALS ALTERNATES AND SUBSTITUTIONS

- A. General: See details for alternates and substitution in specification section 270010
- B. Substitutions are acceptable for this system as long as the complete integration functionality described in this specification section with other systems is kept exactly as indicated in this specification
- C. Sensors such as door position switches, tamper switches, motion sensors, panic buttons allow substitutions.

1.5 SHOP DRAWINGS AND SUBMITTALS

- A. The IDSI shall follow all requirements for shop drawings indicated in specification section 270010.
- B. The submittal process for this scope of work will be a two stage process. The first stage is the product/installer approval. Within 30 business days of receiving contract approval and notice to proceed, the following items shall be submitted to the A&E for review and approval, as part of the product/installer approval process.
 - 1. Proof of Installer qualifications, addressing all requirements of paragraph 1.3 of this specification.
 - 2. Product numbers, specifications, and data sheets for all equipment.
 - 3. Data sheets and samples of all labeling materials and equipment to be used in the project.
 - 4. A complete explanation of the identification method to be used for all equipment and cabling part of the IDS.
 - 5. Data sheets of all termination blocks and mounting accessories to be used in the project. A paragraph shall be added before each data sheet indicating the intended use of each type of termination block.
 - 6. Detailed drawings of all custom products to be used in the project.
 - 7. Data sheets for all wire and cable to be used as part of this system. A paragraph shall be added before each data sheet indicating the intended use (to connect what type of devices) of each cable.
- C. The second stage of the submittal process is the shop drawing process. Shop drawings shall only be submitted after all portions of the product/installer approval have been accepted by the A&E. The following information is required as part of the shop drawings:
 - 1. Floor plans indication all devices to be provided and all cable runs to all devices or junction boxes. Devices for alarm systems shall indicate the zone numbers. All other devices shall have a unique identifier, as they will be programmed in the system.
 - 2. Raceway Riser Diagrams: Detail raceway runs required for the IDS and for systems integration. Include designation of devices connected by raceway, raceway type and size, and type and size of wire and cable fill for each raceway run
 - 3. Point to point wiring diagrams indicating all termination points for each conductor and for each device, cable types and color coding of each termination.
 - 4. Panel schedules in a spreadsheet format, indicating all ports being used and what device is connected to each port. Panel schedules shall be submitted for all alarm panels, zone expanders, output cards, fiber optics distribution frames, Ethernet switches, control panels, termination blocks, etc.
 - 5. Overall system diagrams indicating all head end components, their room location, and all configuration characteristics like IP addresses, serial ports used, etc.
 - 6. Sensor detection patterns and adjustment ranges.

7. Power supply and battery calculations. The IDSI shall provide calculations of power supplies for the alarm panels and battery run time calculations for those panels. Power supplies can only be installed in telecom rooms.

1.6 ABBREVIATIONS

- A. The following abbreviations are used in this document:
 - 1. ADA Americans with Disabilities Act
 - 2. ANSI American National Standards Institute
 - 3. API Application Programming Interface
 - 4. ASCII American Standard Code for Information Interchange
 - 5. AWG American Wire Gauge
 - 6. BPS Bits Per Second
 - 7. CCTV Closed Circuit Television
 - 8. CPU Central Processing Unit
 - 9. DIN (German Institute of Standardization)
 - 10.DPSDoor Position Switch
 - 11. FCC Federal Communications Commission
 - 12. GUI Graphical User Interface
 - 13. ID Identification
 - 14. I/O Input /Output
 - 15. NEC National Electrical Code
 - 16. NEMA National Electrical Manufacturers Association
 - 17. ODBC Open Database Connectivity
 - 18. O&M Operations and Maintenance
 - 19. PIN Personal Identification Number
 - 20. PTZ Pan/Tilt/Zoom
 - 21. REX Request to Exit
 - 22. RoHS Restriction of Hazardous Substances Directive
 - 23. SCS Security Control System
 - 24. SDRAM Synchronized Dynamic Random Access Memory
 - 25. STP Shielded Twisted Pair
 - 26. UL Underwriters Laboratories, Inc.
 - 27. UPS Uninterrupted Power Supply
 - 28. USB Universal Serial Bus
 - 29. UTP Unshielded Twisted Pair
 - 30. VOC Volatile Organic Compounds

1.7 GLOSSARY OF TERMS

- A. The following terms are defined for the purposes of this specification:
 - 1. Acknowledge: The action taken by a security control system operator to indicate that he/she is aware of a specific alarm or tamper state.
 - 2. Action Messages: A set of instructions automatically provided to the operator when an alarm condition is generated.
 - 3. Advisory: A message provided by the security control system to the operator to inform him/her of a condition as reported by the security control system.
 - 4. Alarm Condition: A change of state, as sensed by the security control system, indicating that the security control system has detected a condition which its sensors were designed to detect.
 - 5. API Integration: a method to transfer information between two systems by means of APIs, though an Ethernet communication network.

- 6. Clear: The action taken by a security control system operator to respond to an alarm condition or advisory so that other alarms may be serviced or so that other actions may be taken.
- 7. Download: To send computer data from the File Server to a controller for the purposes of making access decision without the intervention of the File Server.
- 8. Line Supervision: The monitoring of an electrical circuit via electrical and software systems to verify the electrical integrity of the supervised circuit.
- 9. Off-line: A condition in which a controller(s) is not in communication with the File Server. In the off-line mode, the controller continues to make access decisions and process alarms according to the information stored at its local database.
- 10. Password: A combination of numbers or letters unique to security control system operator which defines commands and data fields he/she may view, edit, or command.
- 11. PIR: Passive infrared.
- 12. Protected Zone: A protected premises or an area within a protected premises that is provided with means to prevent an unwanted event.
- 13. Relay integration: A method to transfer signals between two systems by means of using potential free contact closures to input points.
- 14. Reset: A command or feedback signal that indicates that a monitored point has returned to its normal state after having transferred to the alarm or trouble state.
- 15. Secure Mode: The normal state of an alarm input point from which it will be monitored for change of state to either an alarm or trouble condition.
- 16. Secured Area: A physical location within the facility to which access is controlled by one or more card readers.
- 17. Secured side: Side of a security door where a higher security level needs to be granted for a user to be authorized to be in that side of the door.
- 18. Serial line integration: A method to transfer information between two systems by means of an RS-232/RS-422 or RS-485 line, using ASCII strings.
- 19. Standard Intruder: A person who weighs 100 lb (45 kg) or less and whose height is 60 inches (1525 mm) or less; dressed in a long-sleeved shirt, slacks, and shoes.
- 20. Standard-Intruder Movement: Any movement, such as walking, running, crawling, rolling, or jumping, of a "standard intruder" in a protected zone.
- 21. Systems Integration: The bringing together of components of several systems containing interacting components to achieve indicated functional operation of combined systems.
- 22. Tamper: A condition within the circuitry of a monitored point which indicates the electrical integrity of that sensing circuit has been compromised.
- 23. Tamper proof screws: A screw with a security hexalobular internal driving feature as described in ISO 10664. As an example, a security TORX head, as developed by Camcar LLC.
- 24. Time Interval: A time stamp of one start time and one stop time within a time period.
- 25. Time Period: A user programmable period of time made up of days of the week and hours in the day.
- 26. Trouble: A condition within the circuitry of a monitored point which indicates that an equipment malfunction, single break, single fault or a wire-to-wire short exists.
- 27. UPS: Uninterruptible power supply.
- 28. User Definable: An attribute of a security control system function that may be easily tailored by the System Administrator.
- 29. Workstation: A personal computer connected to the main security control system File Server via a local area network connection for the purpose of programming the system and responding to alarms.
- 30. Zone. A defined area within a protected premises. It is a space or area for which an intrusion must be detected and uniquely identified. The sensor or group of sensors must then be assigned to perform the detection, and any interface equipment between sensors and communication must link to master control unit

1.8 FUNCTIONAL DESCRIPTION OF SYSTEM

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

- A. The intrusion detection systems primary purposes shall be to provide alarm monitoring capabilities for the new facility with the ability to be monitored from a third party monitoring system or a local office.
- B. Description: The IDS shall be based on a Hard-wired modular, microprocessor-based controls, intrusion sensors and detection devices, and communication links to perform monitoring, alarm, and control functions.
- C. Supervision: System components shall be continuously monitored for normal, alarm, supervisory, and trouble conditions. Indicate deviations from normal conditions at any location in system. Indication includes identification of device or circuit in which deviation has occurred and whether deviation is an alarm or malfunction.
 - 1. Alarm Signal: Display at master control unit and actuate audible and visual alarm devices.
 - 2. Trouble Condition Signal: Distinct from other signals, indicating that system is not fully functional. Trouble signal shall indicate system problems such as battery failure, open or shorted transmission line conductors, or control-unit failure.
 - 3. Supervisory Condition Signal: Distinct from other signals, indicating an abnormal condition as specified for the particular device or control unit.
- D. System Control: Master control unit shall directly monitor intrusion detection units and connecting wiring.
- E. System Control: Master control unit shall directly monitor intrusion detection devices, and connecting wiring in a multiplexed distributed control system or as part of a network.
- F. System shall automatically reboot program without error or loss of status or alarm data after any system disturbance.
- G. Operator Commands:
 - 1. Help with System Operation: Display all commands available to operator. Help command, followed by a specific command, shall produce a short explanation of the purpose, use, and system reaction to that command.
 - 2. Acknowledge Alarm: To indicate that alarm message has been observed by operator.
 - 3. Place Protected Zone in Access: Disable all intrusion-alarm circuits of a specific protected zone. Tamper circuits may not be disabled by operator.
 - 4. Place Protected Zone in Secure: Activate all intrusion-alarm circuits of a protected zone.
 - 5. Protected Zone Test: Initiate operational test of a specific protected zone.
 - 6. System Test: Initiate system-wide operational test.
 - 7. Print reports.
- H. Timed Control at Master Control Unit: Allow automatically timed "secure" and "access" functions of selected protected zones.
- I. Response Time: Two seconds between actuation of any alarm and its indication at master control unit.
- J. Circuit Supervision: Supervise all signal and data transmission lines, links with other systems, and sensors from master control unit. Indicate circuit and detection device faults with both protected zone and trouble signals, sound a distinctive audible tone, and illuminate an LED. Maximum permissible elapsed time between occurrence of a trouble condition and indication at master control unit is 20 seconds. Initiate an alarm in response to opening, closing, shorting, or grounding of a signal or data transmission line.

- K. Programmed Secure-Access Control: System shall be programmable to automatically change status of various combinations of protected zones between secure and access conditions at scheduled times. Status changes may be preset for repetitive, daily, and weekly; specially scheduled operations may be preset up to a year in advance. Manual secure-access control stations shall override programmed settings.
- L. Manual Secure-Access Control: Coded entries at manual stations shall change status of associated protected zone between secure and access conditions.

PART 2 - PRODUCTS

2.1 SYSTEM COMPONENT REQUIREMNTS

- A. Compatibility: Detection devices and their communication features, connecting wiring, and master control unit shall be selected and configured with accessories for full compatibility with the following equipment:
 - 1. Door hardware specified in Division 08 Section "Door Hardware."
 - 2. Door hardware specified in Division 08 Section "Door Hardware (Scheduled by Describing Products)."
 - 3. Other systems required to be integrated with the IDS
- B. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor entry connection to components.
 - 1. Minimum Protection for Power Lines 120 V and More: Auxiliary panel suppressors complying with requirements in Division 26 Section "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits."
 - 2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Listed and labeled by a qualified testing agency for compliance with NFPA 731.
- C. Intrusion Detection Units: Listed and labeled by a qualified testing agency for compliance with UL 639.
- D. Interference Protection: Components shall be unaffected by radiated RFI and electrical induction of 15 V/m over a frequency range of 10 to 10,000 MHz and conducted interference signals up to 0.25-V rms injected into power supply lines at 10 to 10,000 MHz.
- E. Tamper Protection: Tamper switches on detection devices, control units, annunciators, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled and when entering conductors are cut or disconnected. Master control-unit alarm display shall identify tamper alarms and indicate locations.
- F. Self-Testing Devices: Automatically test themselves periodically, but not less than once per hour, to verify normal device functioning and alarm initiation capability. Devices transmit test failure to master control unit.
- G. Antimasking Devices: Automatically check operation continuously or at intervals of a minute or less, and use signal-processing logic to detect blocking, masking, jamming, tampering, or other operational dysfunction. Devices transmit detection of operational dysfunction to master control unit as an alarm signal.

- H. Addressable Devices: Transmitter and receivers shall communicate with a unique device identification and status reports to master control unit.
- I. Remote-Controlled Devices: Individually and remotely adjustable for sensitivity and individually monitored at master control unit for calibration, sensitivity, and alarm condition.

2.2 SYSTEM ENCLOSURES

- A. All electronics part of the IDS system shall be installed inside protected metallic enclosures. This enclosure shall protect against dust, falling dirt, dripping noncorrosive liquids and tampering.
- B. Use NEMA 250, Type 12 enclosures when the electronic parts of the IDS will be installed at interior spaces, with temperature and humidity control.
- C. Use NEMA 250, Type 4X, fiberglass enclosures when the electronic parts of the IDS will be installed at exterior spaces, without temperature and humidity control.
- D. All enclosures shall have a hinged doors with key locks (all keys shall be keyed alike) and tamper switches.
- E. Enclosures shall be sized by IDSI to be capable of housing all electronics, batteries, termination blocks and power supplies.
- F. Design selection: as recommended by manufacturer of the intrusion detection system. For exterior enclosures the basis of design are nVent enclosures.

2.3 TAMPER SWITCH

- A. All security enclosures, including power supplies or terminations shall include a tamper switch for direct supervision of the cabinet door. Any opening of these doors shall initiate an alarm condition to the security monitoring system. All tamper contacts shall be a reed actuated self adjusting plunger style switch. If a tamper contact is provided by the manufacturer with the enclosure this device may be used.
- B. Tamper switches shall be wired as to report separate alarms to the system for each panel.
- C. Basis of design: Amseco PSW-1, or as provided by the IDS system manufacturer.

2.4 INTRUSION ALARM PANEL

- A. An intrusion alarm system shall be provided to connect, control and monitor wired duress buttons to the security system. The intrusion alarm system shall be provided with a panel, keypads, and additional system modules.
- B. The Intrusion Alarm panels shall be provided with an Ethernet network card or a RS-232 communication line to integrate with the other systems.
- C. Power supply: Power for the main intrusion alarm panel shall be done through multiple devices such as a transformer a power supply module/charger and batteries. All components of the power supply shall be housed in a system enclosure. Batteries shall be provided for the intrusion alarm panel with a minimum run time of 12 hours.

- D. The intrusion alarm panel shall have the ability add optional modules such as:
 - 1. Communicator module.
 - 2. 8-Zone expansion module.
 - 3. 8-Low current output expander module.
 - 4. 4-High current output expander module.
- E. The IDSI shall configure all modules in the selected system to accomplish the design intent described in this specification and in the design drawings. The complete configuration of the alarm system shall be submitted as part of the as built information for this specification.
- F. The Intrusion Alarm System shall have the following minimum capacities:
 - 1. Main panel with 8 on-board zones, expandable to 128 hard wired zones.
 - 2. Zone types: 40 zones types with 14 programmable zone attributes
 - 3. Up to 98 access codes: one master code, one installer code and one maintenance code.
 - 4. Programmable attributes for each user code
 - 5. Up to 4 programmable outputs (PGM)
 - 6. A maximum of 148 programmable outputs through expansion modules
 - 7. The system shall be capable of monitoring the following events:
 - a. AC power failure
 - b. Zone trouble
 - c. Telephone line trouble
 - d. Communicator trouble
 - e. Low battery condition
 - f. RF jam
 - g. AUX power supply fault
 - h. Failure to communicate
 - i. Module fault
 - Additional features:

8.

- a. 2-way wireless device support
- b. Visual verification
- c. Proximity tag support
- d. PGM scheduling
- e. Quick arming
- f. Up to 8 user partitions
- g. Programmable system loop response
- h. Door bell zones
- i. Low battery PGM type
- G. Basis of Design: Honeywell, Bosch. Other intrusion detections system could be considered if the IDSI can demonstrate all functional features are equal including integration requirements with other systems.

2.5 INTRUSION ALARM KEYPAD

- A. The intrusion alarm keypad shall be a single unit capable of connecting to the main panel through a serial communication line. The unit shall have the following features:
 - 1. Global partition status
 - 2. Up to 128 hardwired or wireless zones supported
 - 3. Full 32-character programmable labels
 - 4. Menu programming
 - 5. Modern, slim-line landscape keypad
 - 6. White backlit keys
 - 7. Blue LCD display with 2X16 characters capacity
 - 8. Displays outdoor temperature
 - 9. 5 programmable function keys

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 121505 Intrusion Detection Systems Section 28 1010 - 8

TLC Engineering Solutions

- 10. Intuitive clock programming
- 11. Input/Output terminal
- 12. Fire, medical and panic keys
- 13. Adjustable backlight and keypad buzzer
- 14. Dual wall-mount and front cover tamper
- B. Basis of design: Match manufacturer selection for Intrusion Alarm Panel.

2.6 MICROWAVE-PIR DUAL-TECHNOLOGY SENSORS

- A. Description: Single unit combining a sensor that detects changes in microwave signals and a PIR sensor that detects changes in ambient level of infrared emissions caused by standard-intruder movement within detection pattern.
- B. Listed and labeled by a qualified testing agency for compliance with SIA PIR-01.
- C. Device Performance: An alarm is transmitted when either sensor detects a standard intruder within a period of three to eight seconds from when the other sensor detects a standard intruder.
- D. Minimum Detection Pattern: A room 20 by 30 feet
- E. PIR Sensor Sensitivity: Adjustable pattern coverage to detect a change in temperature of 2 deg F or less, and standard-intruder movement within sensor's detection patterns at any speed between 0.3 to 7.5 fps across two adjacent segments of detector's field of view.
- F. Microwave Sensor Sensitivity: Adjustable, able to detect standard-intruder movement within sensor's detection pattern at any speed between 0.3 to 7.5 fps. Sensor sensitivity adjustments shall be accessible only when sensor housing is removed, and sensors shall comply with 47 CFR 15.
- G. Activation Indicator: LED indicator shall not be visible during normal operation. Indicator shall light when sensor detects a standard intruder. Locate test enabling switch under sensor housing cover.
- H. Remote Test: When initiated by master control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.
- I. Basis of Design: Interlogix, DSC, Bosch

2.7 360 DEG MOTION SENSOR – CEILING MOUNTED

- A. Description: Single unit combining a sensor that detects changes in microwave signals and a PIR sensor that detects changes in ambient level of infrared emissions caused by standard-intruder movement within detection pattern.
- B. Listed and labeled by a qualified testing agency for compliance with SIA PIR-01.
- C. Device Performance: An alarm is transmitted when either sensor detects a standard intruder within a period of three to eight seconds from when the other sensor detects a standard intruder.
 - 1. Minimum Detection Pattern: A room 20 by 30 feet (6 by 9 m).

- 2. PIR Sensor Sensitivity: Adjustable pattern coverage to detect a change in temperature of 2 deg F (1 deg C) or less, and standard-intruder movement within sensor's detection patterns at any speed between 0.3 to 7.5 fps (0.09 to 2.3 m/s) across two adjacent segments of detector's field of view.
- 3. Microwave Sensor Sensitivity: Adjustable, able to detect standard-intruder movement within sensor's detection pattern at any speed between 0.3 to 7.5 fps (0.09 to 2.3 m/s). Sensor sensitivity adjustments shall be accessible only when sensor housing is removed, and sensors shall comply with 47 CFR 15.
- 4. Activation Indicator: LED indicator shall not be visible during normal operation. Indicator shall light when sensor detects a standard intruder. Locate test enabling switch under sensor housing cover.
- 5. Remote Test: When initiated by master control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.
- D. Basis of design: Interlogix, DSC, Bosch

2.8 DOOR POSITION SWITCH - DPS

- A. The IDSI shall coordinate with the door hardware installer on the placement of magnetic door position switch required for hollow metal doors for this project.
- B. When the design drawings indicate a door is to get a DPS for card access and a DPS for the IDS, the IDSI shall provide a DPS with DPDT contacts to allow for one set of contacts to be wired to the card access system and the second set of contacts to be wired to the intrusion alarm panel
- C. On double doors where each leaf has a DPS, the devices shall be wired in series. Both sensors shall report alarms to the system as a single alarm point.
- D. Basis of design: Interlogix 1078 series or approved equal.

2.9 ACOUSTIC-TYPE, GLASS-BREAK SENSORS

- A. Listed and labeled by a qualified testing agency for compliance with SIA GB-01.
- B. Device Performance: Detect unique, airborne acoustic energy spectrum caused by breaking glass.
- C. Sensor Element: Microprocessor-based, digital device to detect breakage of plate, laminate, tempered, and wired glass while rejecting common causes of false alarms. Detection pattern shall be at least a 20-foot (6-m) range.
- D. Hookup Cable: Factory installed, not less than 72 inches
- E. Activation Indicator: LED on sensor housing that lights when responding to vibrations, remaining on until manually reset at sensor control unit or at master control unit.
- F. Control Unit: Integral with sensor housing or in a separate assembly, locally adjustable by control under housing cover.
- G. Glass-Break Simulator: A device to induce frequencies into protected glass pane that simulate breaking glass without causing damage to glass.

H. Basis of design. Interlogix, DCS, BOSCH

2.10 VIBRATION SENSORS

- A. Listed and labeled by a qualified testing agency for compliance with SIA GB-01.
- B. Description: A sensor control unit and piezoelectric crystal sensor elements that are designed to be rigidly mounted to structure being protected.
- C. Device Performance: Detects high-frequency vibrations generated by use of such tools as oxyacetylene torches, oxygen lances, high-speed drills and saws, and explosives that penetrate a structure while not responding to any other mechanical vibration.
- D. Circular detection pattern, with at least a 72-inch (1830-mm) radius on protected structure.
- E. Hookup Cable: Factory installed, not less than 72 inches (1830 mm).
- F. Control Unit: Integral with sensor housing or in a separate assembly, locally adjustable by control under housing cover.
- G. Glass-Break Simulator: A device to induce frequencies to protected glass pane that simulate breaking glass without causing damage to glass.
- H. Basis of design. Interlogix, DCS, BOSCH

2.11 WALL MOUNTED DURESS BUTTON

- A. The wall mounted duress button shall be a mushroom type button capable of fitting in a 4"x4" electrical box with a single device adapter. The specifications of the wall mounted duress button are:
 - 1. Operation: push button once to engage, release by use of keyswitch.
 - 2. Plate construction: ¹/₄" extruded aluminum plate with beveled edge
 - 3. Switch mode operation: latching maintained action.
 - 4. Switch configuration: 1 X SPST N/O and 1 X SPST N/C
 - 5. Button finish: red cap.
 - 6. Screws: tamper resistant.
- B. All duress button keys shall be key alike.
- C. Basis of design: Rutherford controls International model 920 or approved equal.

2.12 DURESS BOTTOM – UNDER DESK

A. The unit shall consist of a housing that contains the electrical circuitry and magnetic reed contact, a cover plate to protect the internal electronics and actuating lever with an Alnico-V magnet installed in the cradle lever. The alarm shall occur when the actuating lever is moved 20 to 45 degrees past the fully closed position. The unit shall feature a glowing LED for low light visibility, when powered up this shall be lighted green, when activated this light shall glow red. The unit shall be mounted in specific locations of rooms indicated on the drawings. Obtain client approval on these locations prior to locating these devices.

B. Basis of design: Interlogix 3040 series panic switch or an approved equal

2.13 AUDIBLE AND VISUAL ALARM DEVICES

- A. Klaxon Weatherproof Motor-Driven Hooter: UL listed, rated to produce a minimum sound output of 120 dB at 3 feet, plus or minus 3 dB, at a frequency of 470 Hz. Rated for intermittent use: two minutes on and five minutes off.
 - 1. Designed for use in industrial areas and in high-noise, severe-weather marine environments.
- B. Basis of Design; DSC, Bosch
- C. General. The siren alarm for the intrusion detection system shall be and audible and visual device designed to operate in outdoor or indoor environments. The specifications of the unit shall be:
 - 1. Sound pressure level: 115 dB @ 1m.
 - 2. Sound output: warble sound.
 - 3. Strobe color: Blue
 - 4. Strobe flash rate: 20 to 100 times per minute.
 - 5. Strobe candela on axis: 1.8 minimum
 - 6. Enclosure: Weather-resistant polycarbonate housing with dual tamper screws that mounts on a standard 4" square backbox.
- D. Basis of Design: Amseco SSX-52SB.

2.14 SURGE PROTECTION

A. All security components mounted outside the building and wired through low voltage copper conductor back to the building shall be provided with surge and lighting protection. Provide UL listed multi-stage protection on all low voltage and signal transmission lines. All 120 VAC surge suppression devices shall be EDCO HSP121BT-1RU or an approved equal. For low voltage connections provide FAS-1 surge suppressors manufactured by EDCO or an approved equal. For RS-485 or RS-422 connections provide PC642C-008LC with base PCB1B manufactured by EDCO or an approved equal.

2.15 POWER SUPPLY – FOR IDS SENSORS

- A. Power supplies for IDS sensors shall be completely separate from power supplies for the main alarm control panel. A short circuit line in the power to a sensor shall not disable the operation of the main alarm control panel.
- B. The power supply shall convert a 115 VAC 60 Hz input to a continuously supplied current of 12 VDC. The power supply shall also have a battery charger component and the ability to be powered from battery power. The power supply shall be UL listed, NFPA compliant, and have multiple class 2 rated outputs. The power supply shall be housed in NEMA 1 hinged cover enclosures where mounted indoors. All enclosure doors shall be key lockable, keyed alike, and shall include a tamper switch for monitoring by the security system. Any cabinet opening shall initiate an alarm condition to the security monitoring system.

- C. Maintenance free batteries shall be provided with all power supplies. Batteries shall be sized to allow at least 4 hours of power backup. All power supplies shall be monitored for low battery through the access control system.
- D. Basis of design: Altronix AL300ULXPD16CD or approved equal.

2.16 **POWER SUPPLY – FOR IDS HARDWARE**

- A. Power supplies for IDS hardware shall be a plug in transformer secured to the outlet so it will not fall off from the outlet.
- B. The power supply shall convert a 115 VAC 60 Hz input to a continuously supplied current of 16 VAC at 40 VA. The power supply shall be UL listed, NFPA compliant, and have a class 2 rated output. The power supply shall be housed in NEMA 1 hinged cover enclosures when mounted indoors. All enclosure doors shall be key lockable, keyed alike, and shall include a tamper switch for monitoring by the security system. Any cabinet opening shall initiate an alarm condition to the security monitoring system.
- C. Basis of design: DSC. Bosch, Interlogix

2.17 DIN-RAIL MOUNTED RELAYS

- A. General Description: These DIN rail mounted relays shall have the following specifications:
 - 1. Number of contacts: 2 –Poles
 - 2. Contact type: Form C
 - 3. Contact material: AgCdO (silver tin oxide) or Gold plating
 - 4. Contact rating: 8 A minimum or as required by load
 - 5. Insulation voltage: 250V IEC, 300V UL
 - 6. Coil voltages: 24 VDC
 - 7. Enclosure design: Slim line design. Width less than 0.5"
- B. All DIN rail mounted relays shall be provided with a base made of molded high dielectric material, with terminal screw sockets for all contacts. All bases shall be capable of mounting on a standard DIN (#3) 35 mm wide rail and shall be of the screw terminal type.
- C. All DIN rail mounted relays shall be provided with end clamps at the ends of each row of devices and shall be mounted inside security enclosures.
- D. Design selection: Rockwell Automation series 700-HK or equal

2.18 WIRE & CABLE

- A. Cables for un-powered security sensors shall have the following specification:
 - 1. Minimum cable gauge: AWG 20
 - 2. Number of conductors: 2, stranded conductors
 - 3. Conductor type: Bare copper
 - 4. Cable insulation: Color coded PVC
 - 5. Conductor insulation colors: Black and red.
 - 6. Voltage rating: 300V
 - 7. Cable shield: No cable shields
- B. Cables for powered security sensors shall have the following specifications:

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 121505 Intrusion Detection Systems Section 28 1010 - 13

- 1. Minimum cable gauge: AWG 20
- 2. Number of conductors: 4, stranded conductors
- 3. Conductor type: Bare copper
- 4. Cable insulation: Color coded PVC
- 5. Conductor insulation colors: Black, red, white and green.
- 6. Voltage rating: 300V
- 7. Cable shield: No cable shields
- C. Cables for RS-232, RS-422 or RS-485 control lines shall have the following specifications:
 - 1. Minimum cable gauge: AWG 24
 - 2. Number of conductors: 2-paired, stranded conductors
 - 3. Conductor type: Tinned copper
 - 4. Cable insulation: Polyethylene
 - 5. Conductor insulation colors: White-blue, blue-white white-orange and orange-white
 - 6. Voltage rating: 300V
 - 7. Cable shield: Aluminum/polyester foil (overall), a tinned copper braid (90% coverage) and a AWG 24 tinned copper drain wire
 - 8. Nominal characteristic impedance: 120 Ohms
 - 9. Nominal capacitance: 12.8 pF/ft.
 - 10. Nominal delay: 1.6 ns/ft.
 - 11. Nominal attenuation: 0.6 dB/100 ft @ 1 MHz.
- D. Cables for low voltage power supplies shall have the following specifications:
 - 1. Minimum cable gauge: AWG 18
 - 2. Number of conductors: 2, stranded conductors
 - 3. Conductor type: Bare copper
 - 4. Cable insulation: PVC
 - 5. Conductor insulation colors: Black and red.
 - 6. Voltage rating: 300V
 - 7. Cable shield: No cable shields
- E. All UTP Category horizontal cables and fiber optic cables for the security system shall be in compliance of all requirements in specification section 271000 and shall be under the same warranty as all UTP category cables and fiber optic cables described in specification section 271000.
- F. Cable gauge: All cable gauges shall be estimated as to allow a maximum of 5% voltage drop from the source to the load. Sizes given previously are only minimum gauges accepted. The IDSI shall always estimate proper values.
- G. Cable jackets: All cable jackets shall be suitable for the environment on which the cables will be installed. Use plenum rated cables when cables are installed in plenum spaces. Use riser rated cables when cables are installed through floor sleeves. Use cable jackets with water-blocking material when installed in underground conduits.
- H. Acceptable manufacturers: Belden, Alpha Wire Company, General Cable and West Penn Wire.

2.19 IDENTIFICATION AND LABELING TAGS

A. The IDSI shall follow labeling materials indicated in specification section 270010.

PART 3 - EXECUTION

3.1 INTRUSION DETECTION SYSTEM FUNCTIONALITY

- A. The purpose of the intrusion detection system is to protect the premises with additional controls beyond what the card access system will provide.
- B. The IDSI shall program and install the system based on the Owner's Security Policy and Procedures Handbook. The IDSI shall coordinate with Owner all aspects of the installation of this system.

3.2 INSTALLATION PRACTICES

- A. General: The IDSI shall follow all installation practices indicated in specification section 270010.
- B. BACKUP POWER. All AC power shall be fed from the buildings power source supported by an emergency backup generator where applicable. The source of the AC power feed shall be identified at termination point of equipment.
- C. MONITORED POWER. All power supplies shall be monitored for AC failure. When power supply provides a form c relay with low battery signaling, this contact shall also be monitored. All AC fail and battery low alarms shall be monitored through individual alarm inputs. Series connections of multiple alarm points shall not be allowed.
- D. POWER DISCONNECT. All power supplies shall be installed with means of disconnect from line power. The preferable method of disconnect is through a breaker in an electrical panel.
- E. NON-PARALELLING OUTPUTS. Power to sensors and other field devices shall be made from individual power supply outputs. Paralleling multiple cables feeding multiple sensors in one terminal of a power supply shall not be allowed.
- F. END OF LINE RESISTORS. All inputs to access control panels and alarm panels shall be wired with end of line resistors for supervisory conditions. Supervisory conditions shall be able to uniquely identify the following conditions:
 - 1. Cable open
 - 2. Cable shorted
 - 3. Sensor activate
 - 4. Sensor inactive.
- G. SINGLE DEVICE ZONES. Each zone shall be wired with only one device. Daisy chain of multiple devices in one zone shall not be allowed.
- H. SPARE CAPACITY. All intrusion Alarm panels shall be provided with at least a 20% spare zone inputs capacity installed.
- I. HIGH LOAD CONTACTS. When IDSI requires outputs in the IDS managing currents above the limits managed by the open collector outputs in the expansion boards, the IDS shall provide a DIN-rail Mounted relays in a panel enclosure with a power supply and all other required accessories for proper mounting
- J. KEYPADS. All IDS shall be provided with at least 2 keypads. One located by the Equipment cabinet the other by an exterior door, where the users must likely will enter and exit the building.

3.3 WIRING METHODS

- A. GENERAL. All proposed wire and cable shall meet or exceed the recommendations established by the equipment manufacturers, and shall comply with all state and local codes.
- B. VISUAL INSPECTION. Visually inspect all wire and cable for faulty insulation prior to installation. Protect cable ends at all times with acceptable end caps.
- C. GROMMETS. Provide grommets and strain relief materials where necessary to avoid abrasion and excess tension on wire and cable.
- D. UTP TERMINATIONS. All termination of UTP Category type multi pair cables shall be done in Insulation Displacement Connectors (IDC), modular plugs or connectors. The use of wire nuts or manually twisting cables and protecting them with electrical tape are not acceptable means of termination.
- E. AWG-18 TERMINATIONS. All cable with gauges larger or equal to AWG-18 and all types of stranded conductors shall be terminated on termination blocks part of an active equipment or in termination blocks supplied by the IDSI. The use of wire nuts or manually twisting cables and protecting them with electrical tape are not acceptable means of termination.
- F. AWG-18 TERMINATIONS. All termination blocks for cables with gauges larger or equal to AWG-18 and all types of stranded conductors shall be of the captive screw type DIN rail mounted (Allen-Bradley or similar), and shall be selected for the appropriate cable gauge and number of conductors. DIN rail mounted termination blocks shall be provided with all accessories like end clamps, jumpers, end barriers, etc, and shall always be mount inside a security enclosure. Up to 2 conductors can be terminated in the same point in a termination block as long as the combined diameter of the conductors does not exceed the maximum cable diameter allowed by the termination block. No more than 2 conductors shall be terminated in the same point at a termination block regardless of the cable gauges.
- G. SMALLER DIAMETER TERMINATION. Termination and splices for AWG-20 or cables with smaller gauges shall be made with compressions style connectors. Wire nuts are not acceptable.
- H. WIRE LEADS. When equipment supplied has wire leads instead of termination end points for connections, the only acceptable methods of connection to field wiring are insulated butt splices, quick release connectors (both ends provided) or quick lock self stripping pig tail connectors. All connectors or splices shall be selected according to the gauge of the cable to be terminated.
- I. FIRE STOPPING. All penetrations through fire rated barriers shall be provided, by the IDSI, with appropriate fire stopping materials in accordance with NFPA requirements and local fire authority having jurisdiction.
- J. NO SPLICES. All cable runs shall be continuous from the device to the equipment. Cable splices shall not be allowed inside conduits, or cable trays.
- K. CABLE SEPARATION. Cables of similar signal level shall be bundled together and kept physically separate from power cords, plug strips or other circuits with different potential. Exposed wire bundles or individual cables shall be neatly secured with self-clinching nylon "TY-Raps" (Thomas & Betts or equal).
- L. CONDUIT FOR IDS. See specification section 27 05 28 for details on conduit for IDS system.
- M. NEAT WORK. Components of the distribution system shall be installed in a neat, workmanlike manner consistent with all best practices.

- N. COLOR CODING. Wiring color codes shall be strictly observed and terminations shall be uniform throughout the building.
- O. FINGER DUCT. On large enclosures (> 18" on any side), finger duct wire managers shall be used inside all equipment panels to properly dress cables.

3.4 IDENTIFICATION AND TAGGING

- A. The IDSI shall follow labeling materials indicated in specification section 270010
- B. All cables shall be labeled at both ends of the cable with the same and unique identifier label.
- C. Cable and equipment identifiers shall follow a standard labeling system like TIA 606. The identification system chosen by the IDSI shall be submitted for approval to the A&E.
- D. All alarm panels shall include a work sheet attached to the interior of the panel/ equipment in plastic envelops. This work sheet shall include the location, type of device and part number of all devices connected to the boards inside those equipments. All names used to identify devices in these worksheets shall match all names and identifiers used in the software or the user interface of the system. A second copy of this worksheet shall be delivered to as part of the asbuilt information.

3.5 INTRUSION DETECTION SYSTEM INTEGRATION.

- A. The IDS shall be integrated with other system such as card access and CCTV system. The scope of the integration shall be as followed.
 - 1. ACCESS CONTROL. Integration with card access shall be done as indicated in specification section 28 10 00.
 - 2. CCTV. Integration of the IDS with the CCTV system shall include the following features:
 - a. Alarm point to camera call up. When a zone in the alarm panel goes into alarm, the CCTV system shall recall the camera view associated with that alarm to the alarm monitor window in the CCTV system.
 - b. Alarm point status. The map graphical interface of the CCTV system shall display the status of the different alarm zones with color indicators, such as green is armed, yellow is disarmed, and red in alarm

3.6 INTRUSION DETECTION SYSTEM PROGRAMMING

- A. Programming: It is the responsibility of the IDSI to program all requested features in the IDS as indicated below. There are different levels of programming for the IDS. This is the explanation of each level.
 - 1. HARDWARE PROGRAMMING. On this step all hardware modules are configured, all inputs and output points are assigned names, all partitions are created, system IP addresses, keypads are assigned names, and timing for all devices is established. All this hardware related programming shall be done by the IDSI.
 - 2. USER PROGRAMMING. On this steps access codes, schedules are established for users as well as dial-up information for the system. This user programming step shall be done by the IDSI

3. INTEGRATION PROGRAMMING. Integration of the IDS with other system shall be done as indicated on this specification section. All integration related programming shall be done by the IDSI.

3.7 ADDITIONAL INSTALLER RESPONSIBILITIES

- A. Upon project commencement, the IDSI shall provide qualified technical personnel on-site. Personnel shall be present on each consecutive working day until the system is fully functional and ready to begin the testing phase of this project.
- B. During the installation process the IDSI shall maintain an up-to-date set of as-built shop drawings, which shall always be available for review by the client and/or consulting engineers. This set of documents should be clearly annotated with as-built data as the work is performed. These documents will be reviewed as part of the approval process when evaluating payment request applications. At a minimum, the drawings should contain the following information:
 - 1. Quantity and location of all equipment installed.
 - 2. Cable and wire runs along with the designations tags assigned to each.
 - 3. Wiring diagrams that indicate terminal strip layout, identification, and terminations.
- C. The IDSI Project Manager shall maintain continuous coordination with the A&E. The A&E shall be kept informed of the progress and all conflicts that arise during the course of this project

3.8 REQUEST OF IP ADRESSES

A. The IDSI shall comply with all requirements indicated in specification section 270010 for requesting IP address for the intrusion detection system.

3.9 SYSTEM WARRANTY AND SERVICE

A. General: The IDSI shall follow all warranty and service requirements indicated in specification section 270010.

3.10 ENGINEER'S FINAL ACCEPTANCE TEST

- A. General: The IDSI shall follow all test requirements indicated in specification section 270010.
- B. Additional requirements for the system acceptance test:
 - 1. The day of the final acceptance test the IDSI shall have at least two (2) 2-way radios to communicate between the testing groups. Cell phones are not acceptable for communication since it takes too long to establish communication, and will delay the test substantially. Radios shall be fully charged, and spare batteries shall be available for 8 hours of use.
 - 2. The final acceptance test will be done with two groups of people. Each group will have at least one member of each stakeholder of the project (A&E, Owner, IDSI, General Installer/ Construction Manager). One group will be station in the monitoring room the other group will be going to all locations in the project where security equipment is installed.
 - 3. During the final acceptance test every single device in the intrusion detection system will be tested for normal operation and for simulated alarm conditions at both ends (the field devices and in the monitoring room). When possible, security equipment will be tested for

operation during main power failure. All features requested in this specification will be tested.

C. Testing of all structured cabling system part of the IDS shall be done in accordance of specification section 271000.

3.11 SPARE PARTS

- A. As part of this project the IDSI shall provide the following spare parts:
 - 1. Two (2%) percent of all installed field devices, like local alarms, duress buttons, door position switches, tamper switches, request to exit motion sensors, cell door control panel, door entry systems, etc.
 - 2. One (1) Power supply of each type
 - 3. Two (2) surge protection devices of each type used in the project.
- B. A list of delivered spare parts shall be included with the close out information. This list shall indicate all components delivered and shall be signed received by the Owner. The name of person receiving the equipment shall be clearly written in the list and the date it was received.

3.12 TRAINING AND INSTRUCTION

- A. General: The IDSI shall follow all training requirements indicated in specification section 270010.
- B. The IDSI shall provide the following levels of training for this project as explained in this section.
- C. MAINTENANCE TRAINING.
 - 1. Maintenance training shall be provided for maintenance and IT personnel. The purpose of this training is to explain how to troubleshoot and replace all field devices and hardware.
 - 2. This training shall cover at least the following topics:
 - a. Trouble shooting and replacement of all field devices.
 - b. Installation of all field panels and settings (jumpers, dip switches, etc).
 - c. Wire labeling system.
 - d. Software system installation and recover from system crashes.
 - e. Detail explanation on all physical keys used in security devices.
 - f. Routine preventive maintenance procedures recommended by equipment manufacturers for all components of the system.
 - 3. This training shall be provided by personnel working directly for the IDSI or a direct employee of the manufacturer of the system.
 - 4. One session of this type of training shall be provided and video-taped. This session shall last no less than 8 hours, broken down into different day sessions no longer than 6 hours each.
 - 5. Each session could have up to 5 trainees.
 - 6. The approved O&M manuals shall be available at the time of the training.

3.13 AS-BUILT DOCUMENTS AND CLOSE OUT INFORMATION.

- A. General: The IDSI shall follow all as built and close out information requirements indicated in specification section 270010.
- B. Additional requirements for as-built documentation shall include:

- 1. Approved as-built drawings shall be a complete set of floor plans drawings, riser diagrams, and wiring details indicating the layout and interconnection of the system. All cable routings and elevation of each outlet, tie, and riser cable terminations shall be required.
- 2. Each sensor in the as-built drawings shall include the zone number (or address) used in the system.
- 3. The content of the as-built information shall be no less than the content provided during the shop drawings, and shall be modified as per changes done during construction.
- C. Close out information shall also include:
 - 1. Completed Worksheets for the programming and configuration of the IDS filled out with all the information used in the programming of the IDS.
 - 2. Testing reports for structured cabling system used for the IDS.

END OF SECTION 281010

SECTION 28 2000 CLOSED CIRCUIT TELEVISION/VIDEO SURVEILLANCE SYSTEM

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. The scope of work shall include furnishing all labor, all security video cameras, mounts, housings, power supply systems, cabling, connectors and head end components, including all other hardware and software and documentation required to provide a completely operational and working Closed Circuit Television (CCTV) System.
- B. All materials for the structured cabling system (4-pair UTP cables, fiber optic cables and 24-AWG multi-pair 25 pairs or higher) components required for the video surveillance system shall be in compliance with specification Section 271000.
- C. The following parts of the system are not part of this contract:
 - 1. All networking equipment (switches, routers, etc) for the operation of the system
 - 2. Software licenses for the video surveillance system beyond the 36 months included in this contract.

1.2 RELATED DOCUMENTS

- A. General Terms and Conditions of the Contract Documents
 1. Division 16 Electrical
- B. Supplemental: Refer to the specification sections identified below for additional requirements, which are supplemented by this section.
 - 1. 270010 Technology General Provisions
 - 2. 270528 Raceways for Technology
 - 3. 271000 Structured Cabling System
 - 4. 270526 Ground and Bonding for Communications Systems
 - 5. 281000 Electronic Security System

1.3 CCTV INSTALLER QUALIFICATIONS

- A. The Video Surveillance or CCTV installer (CI) selected for this project must be a direct representative of the products they intent to provide. All technicians assigned to install and configure this system shall be factory trained. This company must be of established reputation and experience, regularly engaged in the supply and support of such systems for a period of at least five consecutive years under the current company name. This company shall have a fully staffed office of sales and technical support representatives within 100 miles of this project.
- B. Other required CI qualifications are:
 - 1. The CI shall agree, in writing, as part of their proposal, to provide both warranty and nonwarranty service within 24 hours of notification of a problem. The CI shall be able to perform any and all repairs to the system within 48 hours.
 - 2. The CI, as a minimum, must carry a current limited energy license.
 - 3. The CI shall have staff trained in programming the CCTV system as described in this specification. The CI shall submit as part of the qualifications required, the resume of the

programmers for the CCTV system as well as the training certificates for this staff from the manufacturer of the system.

1.4 MATERIALS ALTERNATES AND SUBSTITUTION

- A. General: See details for alternates and substitution in specification section 270010
- B. Due to compatibility issues with other buildings under the control of the owner, the only approved Digital Video Management System (DVMS) to be provided in this project is Honeywell Pro-watch Integrated Security Suite. No substitutions are accepted for this type of equipment.
- C. Cameras can be substituted as long as they have the same performance specification as the cameras used as basis of design and as long as they are supported by the DVMS. It is the responsibility of the CI to verify and assure the cameras proposed as substitution are supported by the DVMS. Any cost associated with certifying a proposed camera to the DVMS to be used in this project shall be covered by the CI.

1.5 SHOP DRAWINGS AND SUBMITTALS

- A. The CI shall follow all requirements for shop drawings indicated in specification section 270010
- B. The submittal process for this scope of work will be a two stage process. The first stage is the product/installer approval. Within 30 business days of receiving contract approval and notice to proceed, the following items shall be submitted to the Architect and Engineer (A&E) of the project for review, as part of the product/installer approval process.
 - 1. Proof of Installer qualifications, addressing all requirements of paragraph 1.3 of this specification.
 - 2. Product numbers, specifications, and data sheets for all equipment.
 - 3. Data sheets and samples of all labeling materials and equipment to be used in the project.
 - 4. A complete explanation of the identification method to be used for all equipment and cabling part of the CCTV system.
 - 5. Data sheets of all termination blocks and mounting accessories to be used in the project. A paragraph shall be added before each data sheet indicating the intended use of each type of termination block.
 - 6. Detailed drawings of all custom products to be used in the project.
 - 7. Data sheets for all wire and cable to be used as part of this system. A paragraph shall be added before each data sheet indicating the intended use (to connect what type of devices) of each cable.
- C. The second stage of the submittal process is the shop drawing process. Shop drawings shall only be submitted after all portions of the product/installer approval have been accepted by the A&E. The following information is required as part of the shop drawings:
 - 1. Floor plans indication all devices to be provided and all cable runs to all devices or junction boxes. All cameras shall indicate the camera number in the system and the type of camera and mounting.
 - 2. Point to point wiring diagrams indicating all termination points for each conductor and for each device, cable types and color coding of each termination. These diagrams shall be submitted for each camera type.
 - 3. Storage calculation. The CI shall provide a spreadsheet with all the cameras in the project and the proposed recording frame rates, resolutions, activity percentages and times of recording with the total number of storage bytes per camera and a total for the system. The total storage capacity shall be indicated in Terabytes.

- 4. Bandwidth calculation. The CI shall provide a network bandwidth calculation for the system. This calculation shall be presented in the form of a spreadsheet using MBPS as the units listing all cameras in the project. The spreadsheet shall have subtotals per network region associated with a storage area.
- 5. Completely fill out network configuration template provided by TLC Engineering upon request, to explain all network devices to be used in a project and to get IP addresses from the network administrator.
- 6. Video recording server assignment. A list of all the video servers to be provided in the project with a list of all cameras assigned to each server. Each server shall have a total bit rate estimated for all the cameras recorded showing that the capacity requirements of the server comply with the requirements in this specification.
- 7. Panel schedules in a table format, indicating all ports being used and what device is connected to each port. Panel schedules shall be submitted for all camera power supply, multiport encoder/decoders, computer monitor outputs, fiber optics distribution frames, Ethernet switches, patch panels, termination blocks, etc.
- 8. Overall system diagrams indicating all head end components, their room location, and all configuration characteristics like IP addresses, serial ports used, etc.
- 9. A field of view study. This field of view is a collection of still pictures with the precise field of view for each camera to be installed in the project. The field of view shall be the same coverage as the camera specified and will be used to verify installation of the cameras and during acceptance test.
- 10. Outline of the testing process.

1.6 ABBREVIATIONS

- A. The following abbreviations are used in this document:
 - 1. API Application Programming Interface
 - 2. ASCII American Standard Code for Information Interchange
 - 3. BPS Bits Per Second
 - 4. CIF Common Intermediate Format (352 X 240)
 - 5. 2CIF Common Intermediate Format (704 X 240)
 - 6. 4CIF Common Intermediate Format (704 X 480)
 - 7. DVI Digital Visual Interface
 - 8. FCC Federal Communications Commission
 - 9. GUI Graphical User Interface
 - 10. HDMI High Definition Multimedia Interface
 - 11. ID Identification
 - 12. I/O Input /Output
 - 13. IPS Images Per Second
 - 14. MBPS Mega Bits per Second
 - 15. NTP Network Time Protocol
 - 16. NTSC National Television Standard Committee
 - 17. ODBC Open Database Connectivity
 - 18. ONVIF Open Network Video Interface Forum
 - 19. O&M Operations and Maintenance
 - 20. PAL Phase Alternating Line
 - 21. PIN Personal Identification Number
 - 22. PTZ Pan/Tilt/Zoom
 - 23. RAID Redundant Array of Independent Disks
 - 24. RoHS Restriction of Hazardous Substances Directive
 - 25. SDRAM Synchronized Dynamic Random Access Memory
 - 26. STP Shielded Twisted Pair
 - 27. TCP/IP Transmission Control Protocol/Internet Protocol
 - 28. UL Underwriters Laboratories, Inc.

- 29. UPS Uninterrupted Power Supply
- 30. USB Universal Serial Bus
- 31. UTP Unshielded Twisted Pair
- 32. VOC Volatile Organic Compounds

1.7 SYSTEM DESCRIPTION

- A. The CCTV system shall be a TCP/IP network-based, fully distributed digital video system. The CCTV system will utilize local area networks (LAN) as a transmission medium for video, configuration, as well as storage of all data. The CCTV system shall provide full video control at the management point indicated in the design drawings, with additional full selection capability at any point within the network from a computer workstation. The CCTV system shall provide unlimited expansion capability for the addition or modification of any video device or computer workstation.
- B. The CCTV system shall permit normal and event monitoring of all secured areas on digital monitors as required or shown in the specifications and drawings. In all cases, the equipment shall be state of the art, standardized commercial off-the-shelf, and modular. In all cases, the method of communication from remote locations within the network to the central components shall be transparent to the user. Equipment shall be selected and installed so repairs may be accomplished on site by module replacement, utilizing spare components whenever possible.
- C. The intent of this specification is to provide the owner with a distributed networked digital security system. Supplied by the CI, the CCTV system shall be complete and operational per the performance requirements and objectives of these specifications. The CI shall be responsible for the coordination of related work with other trades affecting his/her work or the work of others.
- D. The CCTV System shall be fully integrated with other security components such as access control, alarm monitoring and intercom communications. The system shall be fully integrated with the access control application to allow events to be directly linked to the CCTV surveillance recording system. See specification section 281000 for details of the integration scope of work and the performance required.
- E. All cameras shall be connected and controlled through a CCTV workstation utilizing a standard mouse and keyboard.

PART 2 - PRODUCTS

2.1 DIGITAL VIDEO MANAGEMENT SYSTEM

- A. The digital video management system shall be composed of off the shelf management servers, storage system and the DVMS Software. The recording system shall be based on a Storage Array Network (SAN) configuration. The storage system shall be composed of DVMS management server, DVMS recording servers, storage arrays, and storage expansion units.
- B. The DVMS recording servers shall process all video streams for recording, live viewing, and playback for the cameras assigned to that recorder. Servers shall be provided in quantities as to not any single server being used at more than 75% of the maximum bit rate capacity of the server. Quantities of servers indicated in the drawings are preliminary and the CI shall provide calculations to the A&E of the final quantity of servers to be provided.

- C. The SAN storage arrays and storage expansion shall provide a network attached storage medium for the video servers.
- D. The ;CI shall provide the required RAID-5 storage with all cameras recorded at max resolution, and with frame rates as indicated in paragraph 3.5 for a total of 30 days. It shall be the responsibility of the CI to provide the correct amount of storage based on the camera resolutions indicated on the drawings recording at the parameters provide. Storage calculations shall be provided in the bid documents.

2.2 DIGITAL VIDEO MANAGEMENT SYSTEM SOFTWARE

- A. The CI shall provide all software required for the complete operation of the video surveillance system.
- B. The approved products for this system are:
 - 1. Honeywell Pro-Watch
- C. At a minimum the video surveillance system software shall provide the following key features:
 - 1. Ability to see live video and recorded video in the same application software.
 - 2. Ability to export video to an open standard file like AVI files
 - 3. Ability to integrate with other system with features as indicated in this specification.
 - 4. Support browser based clients and standard client workstation.
 - 5. Have video analytics incorporated into the DVMS.

2.3 DVMS MANAGEMENT SERVER

- A. The DVMS management server shall have the following specifications:
 - 1. Processor: Two (2) Eight Core Processors, at 2.0GHz CPU, Energy Smart
 - 2. Front side bus: 1333 MHz
 - 3. Cache: 4 MB Level 2 / 12 MB Level 3
 - 4. Memory: 32 GB DDR3-1333MHz, Energy Smart
 - 5. Graphics card: SVGA Graphic Card (with VGA connector)
 - 6. Hard drive configuration: Integrated SAS/SATA Raid 6
 - 7. Back plane: 1X8 bay for 2.5" hard drives
 - 8. Hard drives: Four (4) 73GB 15,000 RPM SAS SCSI 3Gbps 2.5" HotPlug hard drives
 - 9. CD/DVD Drive: 24x CD-RW/DVD Rom Drive SATA, internal
 - 10. Network Card: Dual 10/100/1000 Base-T
 - 11. Power supply: Energy Smart redundant power supply with dual cords. NEMA 5-15p 15A 10 ft. cords.
 - 12. USB ports: Minimum six (6) USB 2.0
 - 13. Serial ports: Minimum one (1) RS-232 in DB-9 connector.
 - 14. Options: USB to PS2 adapter for KVM connectivity
 - 15. Mounting: Rack chassis with sliding rapid/versa rails and cable management arm.
 - 16. Operating system: Windows 200X Server as recommended by Nice Systems, with software licenses to connect all workstations and cameras in the project plus 2 spare licenses for workstations and 10 spare licenses for cameras.
 - 17. Warranty: 3 –year warranty.
 - 18. Design Selection: Dell or HP.

2.4 CCTV WORKSTATION

- A. The rack mounted CCTV Workstations shall be a certified industry standard computer in a rack configuration. It must meet all requirements established by the DVMS software manufacturer. As a minimum the system capacity shall be as follows:
 - 1. Processor: Two (2) Six Core Xeon Processors at 3.46 Ghz CPU
 - 2. Front side bus: 1333 MHz
 - 3. Cache: 12MB
 - 4. Memory: 12GB SDRAM, 1333MHz, ECC
 - 5. Ports: 1 Parallel, 2 Serial (DB-9), 10 USB 2.0
 - 6. Graphics card: Two 4GB Graphics Cards SLI, with quad DVI outputs each
 - 7. Hard Drive: Three (3) in RAID 1 configuration 600GB SATA 10K RPM 3.0 Gb/s Hard Drive
 - 8. CD/DVD Drive: One (1) 16X DVD+/-RW SATA with DVD burning software and DVD player software.
 - 9. Network Card: 10/100/1000 Base-T
 - 10. Mounting: rack mounted
 - 11. Accessories: Standard USB keyboard and USB optical mouse.
 - 12. Operating system: Windows version as recommended by Lenel Systems.
 - 13. Other software: Anti-virus software included with one year license.
 - 14. Warranty: 3-years
 - 15. Design Selection: Lenovo
- B. The desk mounted CCTV workstation shall be a supplier certified industry standard computer. It must meet all requirements established by the DVMS software manufacturer and shall have a recommended minimum system capacity as follows:
 - 1. Processor: One (1) Intel i7 processor at 3.4 Ghz CPU
 - 2. Front side bus: 1333 MHz
 - 3. Cache: 8MB
 - 4. Memory: 8GB SDRAM, 1333 Hz
 - 5. Ports: 1 Serial (DB-9), 10 USB 2.0, 2-line in audio, 2 line out audio,
 - 6. Graphics card: 1GB Graphic Card, with dual DVI outputs with sound
 - 7. Speakers: Sound bar to be mounted under the flat panel display. External speakers desk mounted not acceptable.
 - 8. Hard Drive: 500GB SATA 6.0 Gb/s with 16MB DataBurst Cache Hard Drive
 - 9. CD/DVD Drive: One 8X Blu-ray Disc Burner with Blu-ray burning software and Blu-ray player software.
 - 10. Network Card: 10/100/1000 Base-T
 - 11. Power supply: 88% Efficient power supply
 - 12. Energy Efficiency: Energy Star 4.0 Category B, EPEAT gold
 - 13. Mounting: rack mounted, desk mounted, mini-tower or small form factor chassis as indicated in workstation list. For rack mounting, desk top units fitting a rack tray are acceptable. Mini-tower configurations on a shelf are not acceptable for rack mount.
 - 14. Accessories: Standard USB keyboard and USB optical mouse For rack mounted devices, USB to PS2 adapters are required.
 - 15. Operating system: Windows version as recommended by Lenel.
 - 16. Other software: Anti-virus software included with one year license.
 - 17. Warranty: 3-years
 - 18. Design Selection: Lenovo.
- C. The CCTV workstations shall include monitors, converters, and extenders as indicated on the drawings.
- D. The CCTV workstation shall include the DVMS software included.

2.5 DVMS STORAGE ARRAY

- A. The DVMS storage array shall store all recorded video for the required amount of time. The storage array shall also provide the interface with up to three storage expansion units connected via JBOD cable.
- B. Total capacity of the storage array shall have SATA-II hot swap disk drives in a RAID 6 configuration.
- C. Each storage array shall have two 1GbE iSCSI ports for connection to the iSCSI network switch.

2.6 DVMS STORAGE EXPANSION

A. The DMVS storage expansion shall allow an additional 25% of storage capacity. Each expansion unit shall connect to the DVMS storage array through a JBOD cable.

2.7 KVM SLIDE TRAY

A. Rack mount pull out monitor, keyboard, mouse, KVM switch shall allow all equipment requiring a computer type man machine interface to utilize a single point for control and viewing. All equipment shall connect to the KVM for control.

2.8 PTZ IP CAMERA

- A. The PTZ IP camera dome system shall include a built-in 100Base-TX network interface for live streaming to a standard Web browser.
- B. The PTZ IP dome camera dome system shall operate in an IP video system environment specified for this project and shall be controllable form that platform, as well as open architecture connectivity for third-party software recording solutions. The PTZ IP dome camera shall be an ONVIF compliant camera.
- C. The video imager of the PTZ IP camera meet or exceed the following design and performance specifications:
 - 1. Imager type: Progressive scan CMOS
 - 2. Minimum Resolution: 3840x2160 (8 MP)
 - 3. Frame rate: up to 50/60 frames per second @ maximum resolution.
 - 4. Video compression: H.264 (MPEG-4 Part 10/AVC) Baseline, Main and High Profiles, H.265 (MPEG-H Part 2/HEVC) Main Profile or Motion JPEG.
 - 5. Video streams: Multiple, individually configurable streams in H.264, H.265 and motion JPEG.
 - 6. Minimum illumination: Color: 0.15 lux at 50 IRE, F1.6 B/W: 0.003 lux at 50 IRE, F1.6
 - 7. Gain control: automatic
- D. The lens of the PTZ IP camera meet or exceed the following design and performance specifications:
 - 1. Focus: Automatic
 - 2. Iris: auto-iris
 - 3. Zoom: Optical zoom 12X

- E. The dome drive for the PTZ IP camera system shall meet or exceed the following design and performance specifications:
 - 1. Pan capabilities: 360° endless
 - 2. Tilt capabilities: 180° with auto-flip capabilities
 - 3. Pan/Tilt Speed: Variable between 450° per second continuous pan to 0.05° per second
 - 4. Additional PTZ drive features:
 - a. Preset positions: >100 positions.
 - b. Proportional Pan/Tilt Speed: Speed decreases in proportion to the increasing depth of zoom.
 - c. Tour recording (max 10, 16 minutes each)
 - d. Guard tour: max 100
- F. The PTZ IP camera shall have the following network security features and processing abilities:
 1. Security features:
 - a. Password protection,
 - b. IP address filtering,
 - c. HTTPS encryption,
 - d. IEEE 802.1x (EAP-TLS) network access control
 - e. Digest authentication
 - f. User access log.
 - g. Centralized certificate management
 - h. Brute force delay protection
 - Supported protocols: IPv4, IPv6 USGv6, HTTP, HTTPSa, SSL/TLSa, QoS Layer 3 DiffServ, FTP, SFTP, CIFS/SMB, SMTP, Bonjour, UPnP®, SNMP v1/v2c/v3 (MIB-II), DNS, DynDNS, NTP, RTSP, RTP, SRTP, TCP, UDP, IGMP, RTCP, ICMP, DHCP, ARP, SOCKS, SSH, NTCIP, LLDP, MQTT,
 - 3. Analytics: included [not required]
 - 4. Included Analytics:
 - a. Video motion detection.
 - b. Object detection
 - c. People auto-tracking
- G. The PTZ IP camera shall have the these other characteristics:
 - 1. Housing: Metal (aluminum) casing for outdoor cameras and impact resistant polycarbonate housing for interiors
 - 2. Lower dome: acrylic clear dome
 - 3. Power: PoE or Separate 24VDC power connector.
 - 4. Local storage: not required
 - 5. Operating temperature: 0 °C to 50 °C (32 °F to 122 °F)
 - 6. Operating humidity: 10–85% RH (non-condensing)
- H. Approved manufacturers: Axis, Honeywell

2.9 FIXED IP DOME CAMERA

- A. The fixed IP dome camera for this project shall be an integrated camera and dome.
- B. The fixed IP dome camera shall include a built-in 100Base-TX network interface for live streaming to a standard Web browser.
- C. The fixed IP dome camera shall operate in an IP video system environment specified for this project and shall be controllable form that platform, as well as open architecture connectivity for third-party software recording solutions.
- D. The fixed IP dome camera shall meet or exceed the following design and performance specifications:
 - 1. Image sensor type: Progressive scan RGB CMOS
 - 2. Minimum image resolution: 2304x1728 (4 MP)
 - 3. Frame rate: 30 fps at the maximum resolution possible in the camera.
 - 4. Video streaming: Multiple, individually configurable streams in H.264 and H.265
 - 5. Video compression: H.264 (MPEG-4 Part 10/AVC) Baseline, Main and High Profiles and H.265 (MPEG-H Part 2/HEVC) Main Profile.
 - 6. Lens: Varifocal with an ability to provide a horizontal field of view from 50° to 90°
 - 7. Focus/zoon (back focus): Manual
 - 8. Minimum illumination: 0.12 lux at 50 IRE
 - 9. Camera adjustment: manual pan adjustment 360° and tilt adjustment 80°
 - 10. Audio input/output: Input for external microphone or line-level device, Line output with automatic gain control.
 - 11. Network security: Password protection, IP address filtering, IEEE 802.1X (EAP-TLS) network access control a , HTTPSa encryption, digest authentication, user access log, centralized certificate management, brute force delay protection, signed firmware.
 - 12. Supported protocols: IPv4, IPv6 USGv6, HTTP, HTTPS, SSL/TLSa, QoS Layer 3 DiffServ, FTP, SFTP, CIFS/SMB, SMTP, Bonjour, UPnPTM, SNMP v1/v2c/v3 (MIB-II), DNS, DynDNS, NTP, RTSP, RTP, SFTP, TCP, UDP, IGMP, RTCP, ICMP, DHCP, ARP, SOCKS, SSH, SIP, LLDP, MQTT.
 - 13. Included Analytics:
 - a. Video motion detection.
 - b. Object detection
 - c. Loitering behavior.
 - 14. Casing: Polycarbonate impact resistant (IK10 rated) and weather resistant IP52 (rated).
 - 15. Lower dome: clear.
 - 16. Power connection: PoE IEEE 802.3af/802.3at Type 1
 - 17. IR illumination: required for exterior cameras with a range up to a minimum of 100 ft.
 - 18. Local storage: not required
 - 19. Operating temperature: 0° C to 50° C (32° F to 122°F)
 - 20. Operating humidity: 10–95% RH (non-condensing)
- E. Approved manufacturers: Axis, Honeywell

2.10 PANORAMIC MULTI-IMAGER FIXED IP DOME CAMERA

- A. The panoramic multi-imager fixed IP dome camera for this project shall be an integrated camera and dome.
- B. The panoramic multi-imager fixed IP dome camera shall include only one built-in 100Base-TX network interface for live streaming to a standard Web browser.
- C. The panoramic multi-imager fixed IP dome camera shall operate in an IP video system environment specified for this project and shall be controllable form that platform, as well as open architecture connectivity for third-party software recording solutions.
- D. The panoramic multi-imager fixed IP dome camera shall meet or exceed the following design and performance specifications:
 - 1. Image sensor type: Three (3) or four (4) Progressive scan RGB CMOS
 - 2. Maximum imager resolution: 4x 2560x1440 (15 MP)
 - 3. Frame rate: 30 fps at all resolutions.
 - 4. Video streaming: Multiple, individually configurable streams in H.264 and H2.265

- 5. Video compression: H.264 (MPEG-4 Part 10/AVC) Baseline, Main and High Profiles and H.265 (MPEG-H Part 2).
- 6. Lens: Fixed focus or varifocal with the ability to provide 180° or 360° field of view, as indicated in the design drawings, with all the imagers.
- 7. Minimum illumination: 0.3 lux at 50 IRE
- 8. Network security: Password protection, IP address filtering, IEEE 802.1X (EAP-TLS) network access control a , HTTPSa encryption, digest authentication, user access log, centralized certificate management, brute force delay protection, signed firmware.
- 9. IP address: One IP address for all imagers.
- Supported protocols: IPv4, IPv6 USGv6, HTTP, HTTPS, SSL/TLSa, QoS Layer 3 DiffServ, FTP, SFTP, CIFS/SMB, SMTP, Bonjour, UPnPTM, SNMP v1/v2c/v3 (MIB-II), DNS, DynDNS, NTP, RTSP, RTP, SFTP, TCP, UDP, IGMP, RTCP, ICMP, DHCP, ARP, SOCKS, SSH, SIP, LLDP, MQTT.
- 11. Included Analytics:
 - a. Video motion detection.
- 12. Casing: Polycarbonate impact resistant (IK9 rated or higher) and weather resistant IP66 (rated).
- 13. Lower dome: clear.
- 14. Power connection: PoE IEEE 802.3af/802.3at Type 1
- 15. Operating temperature: 0 °C to 50 °C (32 °F to 122 °F)
- 16. Operating humidity: 10–95% RH (non-condensing)
- E. Approved manufacturers: Axis, Honeywell

2.11 CAMERA MOUNTS AND ADAPTERS

- A. All cameras shall be provided with the mounts and adapters as indicated in the floor types and mounting types indicated in part 3 of this specification. Each camera type indicated in the floor plans shall be matches to one camera type. Examples of mount and adapters include wall mount, trim rings, corner mounts, pole mounts, suspended pole mounts, etc.
- B. The CI shall choose the mounts based on the equipment being supported. All mounts shall be made by the same manufacturer of the cameras. Custom made mount are not acceptable, unless approved by the A&E.

2.12 FIBER OPTIC TRANSCEIVERS

- A. Fiber optic transceivers shall be used for all cameras with wiring distances that exceed 300 feet and cameras installed outdoors with direct exposure to the elements.
- B. Fiber optic transceivers shall be available for singlemode fiber optic cable.
- C. Field mounted transceivers shall be single port (RJ-45) and shall be capable of being installed inside a 12" x 12" junction box. The field mounted transceiver shall be the Comnet CNFE100 series or approved equal.
- D. Where installed in a rack, provide a rack mount chassis with transceivers designed to mount in the chassis. The chassis shall include a 120 VAC power supply. If the quantity of rack mount transceivers required in an IDF is greater than 3, then a redundant 120 VAC power supply shall be provided. The three transceiver card cage shall be the Comnet C3 or approved equal. The card cage designed to house more than three transceivers shall be the Comnet C2 or approved equal.

2.13 OUTDOOR CCTV CAMERA POWER SUPPLY

- A. All cameras in exterior environments connected to the system through fiber optics and installed far away from a telecommunications room shall be powered through a local outdoor CCTV camera power supply.
- B. The outdoor CCTV camera power supply shall allow for a variety of configurations for powering up to four outdoor units from a single power source and shall allow for 24 VAC output for 1-4 units. The power supply shall allow the capability to handle pan/tilt, heater, and blower operation in addition to the camera; shall allow for one fused output; and be capable of handling up to 4 A (100 VA).
- C. The outdoor power supply shall meet or exceed the following design and performance specifications:
 - 1. Input Voltage 100/120/240 VAC, 50/60 Hz
 - 2. Output Voltage 4/26/28 VAC
 - 3. Required Input Current: 1 A
 - 4. Output Fuse/Circuit Breaker Ratings 4 A
 - 5. Input Connectors: Screw-type barrier strips
 - 6. Output Connectors: Screw-type barrier strips.
 - 7. Input Wire Size: 12-16 gauge solid wire
 - 8. Output Wire Size 16-20 gauge solid or stranded wire
 - 9. Environment: Outdoor
 - 10. Operating Temperature: -50° to 122°F (-46° to 50°C)
 - 11. Construction: Aluminum
 - 12. Finish: Gray polyester powder coat
 - 13. Cable Entry: Hole plugs for 0.75-inch (1.9 cm) conduit
 - 14. Latch: Stainless steel link-lock latch; can be secured with a padlock.
 - 15. Certifications: UL
- D. Design selection: Pelco WCS1-4 or equal.

2.14 SURGE PROTECTION

- A. All CCTV components mounted outside the building shall be provided with surge and lightning protection. Provide UL listed multi-stage protection on all low voltage and signal transmission lines. All 120 VAC surge suppression devices shall be EDCO HSP121BT-1RU or an approved equal. For low voltage connections provide FAS-1 surge suppressors manufactured by EDCO or an approved equal. .
- B. For exposed Ethernet connections with PoE, use EDCO CAT6-E PoE or approved equal.

2.15 WIRE & CABLE

- A. Cables for camera power supply shall have the following specifications:
 - 1. Minimum cable gauge: AWG 18
 - 2. Number of conductors: 2, stranded conductors
 - 3. Conductor type: Bare copper
 - 4. Cable insulation: PVC
 - 5. Conductor insulation colors: Black and red.
 - 6. Voltage rating: 300V
 - 7. Cable shield: No cable shields

- B. HDMI or DVI cables shall be factory made and tested cables. For all DVI connections use an HDMI cable with HDMI to DVI adapters. All HDMI cables shall be capable of passing a signal at 340 MHz,
- C. All UTP Category horizontal cables and fiber optic cables for the CCTV system shall be in compliance of all requirements in specification section 271000 and shall be under the same warranty as all UTP category cables and fiber optic cables described in specification section 271000. Color jacket for wiring for the CCTV system shall be green.
- D. Cable gauge: All cable gauges shall be estimated as to allow a maximum of 5% voltage drop from the source to the load. Sizes given previously are only minimum gauges accepted. The Installer shall always estimate proper values.
- E. Cable jackets: All cable jackets shall be suitable for the environment on which the cables will be installed. Use plenum rated cables when cables are installed in plenum spaces. Use riser rated cables when cables are installed through floor sleeves. Use cable jackets with water-blocking material when installed in underground conduits.
- F. Cable jackets for this project: Except when cables are run continuously in conduit all cable or patch cord cables; jackets for CCTV cables shall be plenum rated.
- G. All cables shall be RoHS compliant and free of VOC. The SSI shall provide proof of compliance for all cables during the submittal process.
- H. Acceptable manufacturers: Belden, Alpha Wire Company, General Cable and West Penn Wire.

2.16 IDENTIFICATION AND LABELING TAGS

A. The CI shall follow labeling materials indicated in specification section 270010.

PART 3 - EXECUTION

3.1 CAMERA MOUNTING TYPES

- A. GENERAL. Cameras in the project can have different mounting types depending on how they will be installed. This is regardless if the cameras are PTZ, fixed or panoramic. The mounting type definitions are all the same regardless of the imager type. The CI shall select the correct accessories for mounting the cameras according to the types indicated in the floor plan drawings.
- B. TYPE 1: Ceiling recessed or semi-recessed application. This type of mount is for interiors, mostly in accessible ceiling spaces although it can be used in hard ceilings. Required accessories for this camera type:
 - 1. Dome backbox to protect the electronics above the ceiling, allowing for flex conduit connections and the use of secondary support string if required.
- C. TYPE 2: Surface mounted vertical mount. This type of mount is for interior or exterior applications, wall mounted. Required accessories for this camera type:
 - 1. Adapter plate (if required) to mount directly into an electrical box.
 - 2. For exterior applications, weatherproofing is required between the wall and the camera.

- 3. For exterior applications, the lower dome shall have a hood with the ability to provide a 180 degree protection at the top of the lower dome to prevent the camera from direct sunlight and water stains.
- 4. For installation directly in concrete walls, columns or other structures where recessing a box is not possible, a backbox is required to provide conduit knock-outs or fittings behind the camera.
- D. TYPE 3: Wall mounted. This type of mount is for interior or exterior applications, wall mounted. Required accessories for this camera type:
 - 1. Wall mount.
 - 2. Only for fixed cameras: Adapter plate (if required) to mount directly into an electrical box.
 - 3. Housing accessories required to attach the camera to the wall mount.
 - 4. When this camera type is indicated in a building corner, a corner mount adapter shall be provided as well.
- E. TYPE 4: Surface mounted horizontal mount. This type of mount is for interior or exterior applications, in hard ceiling conditions. Required accessories for this camera type:
 - 1. Adapter plate (if required) to mount directly into an electrical box.
 - 2. Rings or collars to protect the top part of the dome (if required).
 - 3. For installation directly on concrete/steel decks, a camera base with conduit knockouts or conduit fittings is required.
- F. TYPE 5: Suspended installation. This type of mount is for interior or exterior applications, suspended from ceiling or slab above. Required accessories for this camera type:
 - 1. Pole mount adapter for housing.
 - 2. Pole extension. This could be a section of steel pipe cut and threaded as required for the pole mount adapter.
 - 3. Pole base: this is the device that attaches the pole to the structure above.
 - 4. For installation directly on concrete/steel decks, a base with conduit knockouts or connections is required above the pole extension.
- G. TYPE 7: Pole mounted. This type of mount is for exterior applications on a pole. Required accessories for this camera type:
 - 1. Wall mount.
 - 2. Pole mount adapter.
 - 3. Housing accessories required to attach the camera to the wall mount.

3.2 INSTALLATION PRACTICES

A. General: The CI shall follow all installation practices indicated in specification section 270010

3.3 WIRING METHODS

- A. All proposed wire and cable shall meet or exceed the recommendations established by the equipment manufacturers, and shall comply with all state and local codes.
- B. Visually inspect all wire and cable for faulty insulation prior to installation. Protect cable ends at all times with acceptable end caps.
- C. Provide grommets and strain relief materials where necessary to avoid abrasion and excess tension on wire and cable.

- D. All penetrations through fire rated barriers shall be provided, by the CI, with appropriate fire stopping materials in accordance with NFPA requirements and local fire authority having jurisdiction.
- E. All cable runs shall be continuous from the device to the equipment. Cable splices shall not be allowed inside conduits, or cable trays.
- F. All cameras shall have a camera interface box with disconnect means to horizontal cabling for testing purposes and service. Camera interface boxes shall be located in accessible ceiling spaces as close as possible to the camera. Disconnect means shall be provided for UTP cables in the form of an 8-pin modular plug and receptacle. Disconnect means shall be provide for low voltage camera power cables in the form of insulated spade connectors (female connectors in load side, male connectors in camera side).
- G. All video cable connectors and terminations shall be 3-way crimp-on type and shall including connector cables for 24 VAC input and video/data coax output. Twist on style connectors will not be acceptable for any terminations on this project.
- H. Cables of similar signal level shall be bundled together and kept physically separate from power cords, plug strips or other circuits with different potential. Exposed wire bundles or individual cables shall be neatly secured with self-clinching nylon "TY Raps" (Thomas & Betts or equal). Lacing of cables shall not be permitted.
- I. All cables run part of the CCTV system in areas where ceiling is not accessible or in building exterior shall be in conduit at all times
- J. All termination of UTP Category type multi pair cables shall be done in Insulation Displacement Connectors (IDC), modular plugs or connectors. The use of wire nuts or manually twisting cables and protecting them with electrical tape are not acceptable means of termination.
- K. Components of the distribution system shall be installed in a neat, workmanlike manner consistent with all best practices.
- L. Wiring color codes shall be strictly observed and terminations shall be uniform throughout the building.

3.4 IDENTIFICATION AND TAGGING

- A. All cables, wires, wiring forms, terminal blocks, and terminals shall be clearly identified by preprinted labels or tags. The permanent markings shall clearly indicate the function, source, and destination of all cabling, wire, and terminals. All cables shall be labeled at both ends of the cable with the same and unique identifier label.
- B. Cable and equipment identifiers shall follow a standard labeling system like TIA/EIA-606. The identification system chosen by the CI shall be submitted for approval to the A&E.
- C. All camera power supplies, patch panels shall include a work sheet attached to the interior of the equipment cabinet in plastic envelops. This work sheet shall include the location, type of device and part number of all devices connected to the boards inside those equipments. All names used to identify devices in these worksheets shall match all names and identifiers used in the software or the user interface of the system. A second copy of this worksheet shall be delivered to as part of the as-built information.

3.5 CCTV SYSTEM PROGRAMMING

- A. The CI shall program the CCTV system and the integration to the Security System as indicated in specification section 281000.
- B. IP Video Management System (IPVMS) programming: The CI is responsible for all programming and installation labor associated with the IPVMS and the CCTV workstations, as well as all components to make the system operational. The CI shall program the IPVMS system as to create the minimum amount of traffic in the network, and still comply with all resolutions and frame rates as indicated in this specification.
- C. IP video frame rate setting: The CI shall program all settings for the IPVMS following these criteria:
 - 1. The system shall be programmed for 2 different modes of operation: high activity mode and low activity mode. The CI Installer shall work with the owner to establish in a regular week for each area of the building what hours in each day are considered high activity and what hours of each day are considered low activity.
 - 2. All cameras in low traffic interior non-public hallways or rooms shall be recorded normally at 2fps @ highest resolution during high activity mode. During high activity mode frame rate shall be increased to 15 fps upon motion detection or alarm from access control system in the field of view for at least 5 minutes after motion ceased or alarm cleared. During low activity mode these cameras shall be recorded at 1 fps @ 4CIF. Upon motion detection in the field of view of those cameras, the frame rate shall be increased to 15 fps @ highest resolution for at least 5 minutes after motion ceased.
 - 3. All cameras in public areas inside the building shall be recorded at least at 15 fps @ highest resolution during high activity mode. During low activity mode cameras in these areas shall be recorded at 4 fps @ 4CIF. Upon motion detection in the field of view of those cameras, the frame rate shall be increased to 15 fps @ highest resolution for at least 5 minutes after the motion ceased.
 - 4. All site and exterior cameras shall be recorded at 15 fps @ highest resolution at all times.

3.6 ADDITIONAL INSTALLER RESPONSIBILITIES

- A. Upon project commencement, the CI shall provide qualified technical personnel on-site. Personnel shall be present on each consecutive working day until the system is fully functional and ready to begin the testing phase of this project.
- B. During the installation process the CI shall maintain an up-to-date set of as-built shop drawings, which shall always be available for review by the client and/or consulting engineers. This set of documents should be clearly annotated with as-built data as the work is performed. These documents will be reviewed as part of the approval process when evaluating payment request applications. At a minimum, the drawings should contain the following information:
 - 1. Quantity and location of all equipment installed.
 - 2. Cable and wire runs along with the designations tags assigned to each.
 - 3. Wiring diagrams that indicate terminal strip layout, identification, and terminations.
- C. The CI Project Manager shall maintain continuous coordination with the consulting engineers. The engineers shall be kept informed of the progress and all conflicts that arise during the course of this project. Prior to the start of construction the CI shall submit a complete plan and schedule for proposed operations. This schedule should include information relevant to number of employees assigned to the project, work hours, etc.

3.7 REQUEST OF IP ADRESSES

A. The CI shall comply with all requirements indicated in specification section 270010 for requesting IP address for the security system.

3.8 SYSTEM WARRANTY AND SERVICE

A. General: The CI shall follow all warranty and service requirements indicated in specification section 270010.

3.9 ENGINEER'S FINAL ACCEPTANCE TEST

- A. General: The SSI shall follow all test requirements indicated in specification section 270010.
- B. Additional requirements for the system acceptance test:
 - 1. The day of the final acceptance test the CI shall have at least two (2) 2-way radios to communicate between the testing groups. Cell phones are not acceptable for communication since it takes too long to establish communication, and will delay the test substantially. Radios shall be fully charged, and spare batteries shall be available for 8 hours of use.
 - 2. The final acceptance test will be done with two groups of people. Each group will have at least one member of each stakeholder of the project (A&E, Owner, SSI, General Installer/ Construction Manager). One group will be station in the monitoring room the other group will be going to all locations in the project where security equipment is installed.
 - 3. During the final acceptance test every single camera will be tested in the system. When possible, CCTV equipment will be tested for operation during main power failure. All features requested in this specification will be tested
- C. Testing of all structured cabling system part of the Video Surveillance system shall be done in accordance of specification section 271000

3.10 SPARE PARTS

- A. As part of this project the SSI shall provide the following spare parts:
 - 1. One (1) camera of each type in the project. Electronics only, no enclosures
 - 2. One (1) rack mounted power supply
 - 3. One (1) outdoor power supply.
 - 4. One (1) monitor of each type in the project.
 - 5. One (1) additional surge suppression of each type used in the project.
- B. A list of delivered spare parts shall be included with the close out information. This list shall indicate all components delivered and shall be signed received by the Owner. The name of person receiving the equipment shall be clearly written in the list and the date it was received.

3.11 TRAINING AND INSTRUCTION

- A. General: The CI shall follow all training requirements indicated in specification section 270010.
- B. The CI shall provide two (2) levels of training for this project as explained in this section.

- C. OPERATOR/ADMINISTRATION TRAINING.
 - 1. Operator/Administration training shall be provided for security and IT personnel interacting with the CCTV system in all security monitoring rooms. The purpose of this training is to explain clearly how the complete system operates and what the different status indicators mean.
 - 2. This training shall cover at least the following topics:
 - a. Operation of the CCTV system software (all aspects).
 - b. Operation of all devices inside the security monitoring room.
 - c. Alarm response and alarm reset in the security monitoring room
 - d. Data backup/restore and achieving.
 - e. File import/export.
 - f. Creating reports and print outs.
 - g. Basic system troubleshooting.
 - h. Creating users and password reset.
 - 3. This training shall be provided by personnel working directly for the CI or a direct employee of the manufacturer of the system.
 - 4. One session of this type of training shall be provided and video-taped. This session shall last no less than 24 hours, broken down into day sessions no longer than 6 hours each.
 - 5. Each session could have up to 20 trainees.
 - 6. The approved O&M manuals shall be available at the time of the training.
- D. MAINTENANCE TRAINING.
 - 1. Maintenance training shall be provided for maintenance and IT personnel. The purpose of this training is to explain how to troubleshoot and replace all field devices and hardware.
 - 2. This training shall cover at least the following topics:
 - a. Trouble shooting and replacement of all field devices.
 - b. Installation of all cameras and their settings (jumpers, dip switches, etc).
 - c. Wire labeling system.
 - d. Software system installation and recover from system crashes.
 - e. Detail explanation on all physical keys used in CCTV devices.
 - f. Routine preventive maintenance procedures recommended by equipment manufacturers for all components of the system.
 - g. Detail explanation of source code programming for all devices that have software code specifically compiled for this project (i.e. the control system for the video wall).
 - 3. This training shall be provided by personnel working directly for the CI or a direct employee of the manufacturer of the system.
 - 4. One session of this type of training shall be provided and video-taped. This session shall last no less than 18 hours, broken down into day sessions no longer than 6 hours each.
 - 5. Each session could have up to 5 trainees.
 - 6. The approved O&M manuals shall be available at the time of the training.

3.12 AS-BUILT DOCUMENTS AND CLOSE OUT INFORMATION

- A. General: The CI shall follow all as built and close out information requirements indicated in specification section 270010
- B. Additional requirements for as-built documentation shall include:
 - 1. Approved as-built drawings shall be a complete set of floor plans drawings, riser diagrams, and wiring details indicating the layout and interconnection of the system. All cable routings and elevation of each outlet, tie, and riser cable terminations shall be required.

- 2. The content of the as-built information shall be no less than the content provided during the shop drawings, and shall be modified as per changes done during construction.
- C. Close out information shall also include:
 - 1. Two (2) digital backups of all configuration files and databases part of the CCTV system not earlier than the day after the final acceptance test is approved. These backups shall include a list of all the file names used and a complete description of the system that each file name belong to. The media for these backups shall be a compatible media that can be read by the computer system running the specific software program.
 - 2. Testing reports for structured cabling system used for the CCTV system.

END OF SECTION 282000

SECTION 28 3111 ADDRESSABLE FIRE ALARM SYSTEM

PART1- GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 SECTION INCLUDES

- A. This specification provides the requirements for the creation of a complete network-style addressable intelligent fire alarm system consisting of multiple fire alarm and voice evacuation panels located throughout the facility.
- B. The system shall include but not limited to: Fire Alarm Control Panel(s), Automatic and Manually Activated Voice Evacuation Alarm Subsystem with Firefighter Telephone Communications, Automatic and Manually activated alarm Initiating and Indicating Peripheral Devices and Appliances, raceway, wire and accessories required to furnish a complete and operational Fire Alarm System.

1.3 REFERENCES

- A. The equipment and installation shall comply with the provisions of the following standards:
 - 1. NFPA 70 National Electric Code, 2011 Edition
 - 2. National Fire Protection Association Standards:
 - a. NFPA 72 National Fire Alarm Code, 2010 Edition
 - b. NFPA 90A Standard for the Installation of Air Conditioning and Ventilating Systems, 2012 Edition
 - c. NFPA 99 Health Care Facilities, 2012 Edition
 - d. NFPA 101 Life Safety Code, 2012 Edition
 - 3. Local and State Building Codes:
 - a. Florida Fire Prevention Code 5th Edition
 - b. Florida Building Code 2014 5th Edition
 - c. State Elevator Code 2014 Edition
 - 4. Local Authorities Having Jurisdiction.
 - 5. Underwriters Laboratories Inc.
 - 6. The system and all components shall be listed by Underwriters Laboratories Inc. for use in fire protective signaling system.
 - 7. Americans with Disabilities Act (ADA) and State Equivalents.

1.4 **PROJECT DESCRIPTION**

A. This section of the specification includes the furnishing, installation, and connection of an intelligent reporting, microprocessor controlled, addressable, fire detection and emergency voice

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 121505 Addressable Fire Alarm System Section 28 3111 - 1 alarm communication system. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, control panels, auxiliary control devices, annunciators, power supplies, and wiring as shown on the drawings and specified herein.

- B. The fire alarm system shall comply with requirements of NFPA Standard 72 for Protected Premises Signaling Systems except as modified and supplemented by this specification. The system shall be electrically supervised and monitor the integrity of all conductors.
- C. The system shall be an active/interrogative type system where each addressable device is repetitively scanned, causing a signal to be transmitted to the main fire alarm control panel (FACP) indicating that the device and its associated circuit wiring is functional. Loss of this signal at the main FACP shall result in a trouble indication as specified hereinafter for the particular input.
- D. The facility shall have an emergency voice alarm communication system. Digitally stored message sequences shall notify the building occupants that a fire or life safety condition has been reported. Message generator(s) shall be capable of automatically distributing up to eight (8) simultaneous, unique messages to appropriate audio zones within the facility based on the type and location of the initiating event. Fire Command Centers (FCC) shall also support Emergency manual voice announcement capability for both system wide or selected audio zones, and shall include provisions for the system operator to override automatic messages system wide or in selected zones.
- E. The system shall support multiple Fire Command Centers, which shall be capable of simultaneous monitoring of all system events. All Fire Command Centers shall be individually capable of assuming Audio Command functions such as Emergency Paging, audio zone control functions, and Firefighter's Telephone communication functions for their respective building areas.
- F. Each designated zone shall transmit separate and different alarm, supervisory and trouble signals to its respective Fire Command Center (FCC) and designated personnel in other buildings at the site via a multiplex communication network
- G. The fire alarm system shall be manufactured by an ISO 9001 certified company and meet the requirements of BS EN9001: ANSI/ASQC Q9001-1994.
- H. The system and its components shall be Underwriters Laboratories, Inc. listed under the appropriate UL testing standard as listed herein for fire alarm applications and the installation shall be in compliance with the UL listing.

1.5 PROJECT SCOPE

- A. General: Project scope is to provide a complete fire alarm system for the building areas indicated via creation of a new fire alarm network consisting of a new Notifier NFS2-3030 Fire Alarm Control panel and DVC-EM Voice Evacuation Panel.
 - 1. When providing new fire alarm control panels, all new panels will be sized and equipped with all internal components to include (10) Signaling Line Circuits (SLC) per panel to facilitate the design indicated.
 - 2. Provide all network node installations with high-speed network cards to facilitate the networking of all panels.

- 3. Provide all network panels with the most recent firmware available at the onset of the project. If a newer release is available at project closeout, provide appropriate update prior to closeout.
- B. Basic System Performance:
 - 1. Fire Alarm Network Circuits (FAN) and Digital Audio Loop Circuits (DAL) shall be wired Class A (NFPA Style 6) for interconnection of multiple fire alarm control panels into a single fire alarm network.
 - 2. Signaling Line Circuits (SLC) shall be wired Class A (NFPA Style 6) for alarm, trouble and supervisory signals from all intelligent reporting devices.
 - 3. Initiation Device Circuits (IDC) shall be wired Class B (NFPA Style C) as part of an addressable device connected by the SLC Circuit.
 - 4. Notification Appliance Circuits (NAC) for both visual and audible devices shall be wired Class A (NFPA Style Z) as part of an addressable device connected by the SLC Circuit.
 - 5. On Style 6 or 7 (Class A) configurations a single ground fault or open circuit on the system Signaling Line Circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm.
 - 6. Alarm signals arriving at the FACP shall not be lost following a primary power failure (or outage) until the alarm signal is processed and recorded.
 - 7. Notification Appliance Circuits (NAC) Strobe circuits shall be arranged such that there is a minimum of one strobe circuit per smoke compartment zone and shall not be shared between or serve other zones or smoke compartments, unless noted otherwise on the drawings.
 - Audio amplifiers and tone generating equipment shall be electrically supervised for abnormal conditions. Digital amplifiers shall provide built-in speaker circuits, field configurable as four Class B (Style Y), or two Class A (Style Z) circuits. Refer to drawings for required circuit arrangements.
 - 9. Digital amplifiers shall be capable of storing up to two minutes of digitally recorded audio messages and tones. The digital amplifiers shall also be capable of supervising the connection to the associated digital message generator via the Digital Audio Loop circuit, and upon loss of that connection shall be capable of one of the following system responses:
 - a. The digital amplifier shall automatically broadcast the stored audio message.
 - b. The digital amplifier shall switch to a mode where a local bus input on the digital amplifier will accept an input to initiate a broadcast of the stored message. This bus input shall be connected to a NAC on a local FACP for the purpose of providing an alternate means of initiating an emergency message during a communication fault condition.
 - c. Speaker circuits shall be 25 VRMS. Speaker circuits shall have 20% space capacity for future expansion or increased power output requirements.
 - d. Speaker circuits and control equipment shall be arranged such that loss of any one (1) speaker circuit will not cause the loss of any other speaker circuit in the system.
 - e. Speaker circuits shall be arranged such that there is a minimum of one speaker circuit per notification zone and shall not be shared between or serve other zones, unless noted

otherwise on the drawings. Amplifiers shall be located in dedicated cabinets to simplify installation and to reduce power losses in wiring. Amplifiers for each smoke notification or evacuation zone shall be located within that compartment, unless specifically identified otherwise.

- f. Digital Audio amplifiers and tone generating equipment shall be electrically supervised for abnormal conditions Speaker circuits shall be electrically supervised for open and short circuit conditions. If a short circuit exists on a speaker circuit, it shall not be possible to activate that circuit. Speaker circuits and control equipment shall be arranged such that loss of any one (1) speaker circuit will not cause the loss of any other speaker circuit in the system.
- j. The digital audio message generator shall be of reliable, non-moving parts, and support the digital storage of at least 16 or 32 minutes of tones and emergency messages, shall support programming options to string audio segments together to create up to 1000 messages, or to loop messages and parts of messages to repeat for pre-determined cycles or indefinitely.

1.6 BASIC SYSTEM FUNCTIONAL OPERATION

- A. When a fire alarm condition is detected and reported by one of the system initiating devices, the following functions shall immediately occur:
 - 1. The System Alarm LED shall flash.
 - 2. A local piezo electric signal in the control panel shall sound.
 - 3. The 640-character LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.
 - 4. Printing and history storage equipment shall log the information associated each new fire alarm control panel condition, along with time and date of occurrence.
 - 5. All system output programs assigned via control-by-event interlock programming to be activated by the particular point in alarm shall be executed, and the associated system outputs (notification appliances and/or relays) shall be activated.
 - 6. The audio portion of the system shall sound the proper signal (tone or voice) to the appropriate zones.

1.7 SUBMITTALS

- A. Fire Alarm Shop Drawings: Shop drawings shall be complete showing all wiring diagrams and point to point connections required for this project. The point to point connections shall be indicated on drawings showing routing of raceways, connections, components, and conductor quantities and types. The Contractor shall apply his company name, address, telephone number, etc. Computer CAD drawings are required.
- B. Conduit Shop Drawings: Shop drawings shall be complete showing all proposed conduit routing, including panel/power supply/amplifier/device locations, to ensure both Class A wiring techniques and Survivability are maintained. Drawings shall be submitted with prior to installation to avoid rework of conduit that may not meet the requirements above. Computer CAD drawings are required. It shall be permitted (and suggested) to provide combined drawings showing both wiring and conduit provided each conduit section is clearly marked with the proposed wiring installation.

- 1. Separate conduit drawings shall be provided for both indicating and initiation circuits. Single drawings showing both circuits on the same drawing shall not be permitted.
- 2. Conduit shop drawings shall be made available for AHCA review during site inspections of the fire alarm system. AHCA will be performing a series of inspections dedicated to the installation of the fire alarm system to ensure Class A and survivable design concepts identified in these documents are strictly adhered to.
- C. Software Modifications
 - 1. Provide the services of a factory trained and authorized technician to perform all system software modifications, upgrades or changes. Response time of the technician to the site shall not exceed 4 hours.
 - 2. Provide all hardware, software, programming tools and documentation necessary to modify the fire alarm system on site. Modification includes addition and deletion of devices, circuits, zones and changes to system operation and custom label changes for devices or zones. The system structure and software shall place no limit on the type or extent of software modifications on-site. Modification of software shall not require power-down of the system or loss of system fire protection while modifications are being made.
- D. Product Data: Submit manufacturer's standard catalog data on all components and sub-systems. Product data shall be submitted showing manufacturer's written recommendations for storage and protection, and installation instructions. Manufacturer's product data shall be submitted for all system equipment including;
 - 1. Application Information
 - 2. Dimensions
 - 3. Listing Agency File
 - 4. Wiring Diagrams
 - 5. Installation Information
 - 6. Battery Calculations
 - 7. Circuit Load and Voltage Drop Calculations
- E. Annual Inspections: The Contractor shall provide hourly Service Rates and Semi-Annual inspection prices, performed by a factory trained and authorized personnel, for this installation with the submittal. Proof of training and authorization of the servicing personnel shall be included in the submittal. The hourly service rates shall be guaranteed for a one-year period unless otherwise specified.
- F. Close-out Submittals: Two (2) copies of the following Manual shall be delivered to the Building Owner's representative at the time of system acceptance. The close out submittals shall include:
 - 1. Operating manuals covering the installed Fire Alarm System.
 - 2. Point to Point diagrams of the entire Fire Alarm System as installed. This shall include all connected Smoke Detectors and addressable field modules. All drawings shall be provided in CAD and supplied in standard .dwg format. Bond plots of each sheet shall also be provided. A system-generated point to point diagram is required to ensure accuracy.
 - 3. The application program listing for the system as installed at the time of acceptance by the building owner and/or Local AHJ (Disk and Hard copy printout).
 - 4. Name, address and telephone of the authorized factory representative.

- 5. All drawings must reflect device address and programmed characteristics as verified in the presence of the engineer and/or the end user unless device addressing is electronically generated, and graphically printed.
- 6. Certificate of Training.

1.8 QUALITY ASSURANCE

- A. Qualifications: Provide proof of qualifications as Factory Authorized and Factory Trained for the product(s) specified herein. These qualification credentials shall not be more than two years old, to ensure up-to-date product and application knowledge on the part of the installing firm. Only a factory-trained and certified technician shall program the system. Provide proof of certification of programmer within submittal.
- B. Warranty Period: The Contractor shall provide warranty service at no additional cost to the Owner for a period of 12 months from the date of substantial completion of the installation.
- C. A copy of the manufacturers' warranty shall be provided with closeout documentation and included with the operation and installation manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIAL GENERAL REQUIREMENTS

- A. Equipment: All equipment furnished for this project shall be new, unused and shall be the manufacturer's current model. All components and systems shall be designed for uninterrupted duty. All equipment, materials, accessories, devices, and other facilities covered by this specification or noted on contract drawings and installation specifications shall be the best suited for the intended use and shall be provided by a single manufacturer. If any of the equipment provided under this Specification is provided by different manufacturers, then that equipment shall be recognized as compatible by both manufacturers, and "Listed" as such by Underwriters' Laboratories or similar nationally recognized testing laboratory (NRTL).
- B. Demonstration: System installation and operations shall be verified by the manufacturer's representative and a verification certificate presented upon completion. The manufacturer's representative shall be responsible for an on-site demonstration of the operation of the system and initial staff training as required by the Architect and/or Engineer.

2.2 MANUFACTURERS

- A. Manufacturers: Firms shall be regularly engaged in manufacture of equipment types and service required, whose products have been in satisfactory use in similar service for not less than five years.
- B. Service Availability: The supplier shall have sufficient stock on hand and have a fully equipped service organization capable of guaranteeing response time within 8 hours of service calls, 24 hours a day, 7 days a week to service completed systems.
- C. Approved Manufacturers: Notifier (No Substitutions)
- 2.3. MAIN FIRE ALARM CONTROL PANEL NETWORK NODE:
 - A. The main FACP Central Console shall be a NOTIFIER Model NFS2-3030 and shall contain a microprocessor based Central Processing Unit (CPU). The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent addressable

smoke and thermal (heat) detectors, addressable modules, panel modules including initiating circuits, control circuits, and notification appliance circuits, local and remote operator terminals, printers, annunciators, and other system controlled devices.

- B. In conjunction with intelligent Loop Control Modules and Loop Expander Modules, the main FACP shall perform the following functions:
 - 1. Supervise and monitor all intelligent addressable detectors and monitor modules connected to the system for normal, trouble and alarm conditions.
 - 2. Supervise all initiating signaling and notification circuits throughout the facility by way of connection to addressable monitor and control modules.
 - 3. Detect the activation of any initiating device and the location of the alarm condition. Operate all notification appliances and auxiliary devices as programmed. In the event of CPU failure, all SLC loop modules shall fallback to degrade mode. Such degrade mode shall treat the corresponding SLC loop control modules and associated detection devices as conventional two-wire operation. Any activation of a detector in this mode shall automatically activate associated Notification Appliance Circuits.
 - 4. Visually and audibly annunciate any trouble, supervisory, security or alarm condition on operator's terminals, panel display, and annunciators.
 - 5. When a fire alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:
 - a. The system alarm LED shall flash.
 - b. A local piezo-electric audible device in the control panel shall sound a distinctive signal.
 - c. The 640-character backlit LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.
 - d. Printing and history storage equipment shall log and print the event information along with a time and date stamp.
 - e. All system outputs assigned via preprogrammed equations for a particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.
 - f. When a trouble condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:
 - i. The system trouble LED shall flash.
 - ii. A local piezo-electric audible device in the control panel shall sound a distinctive signal.
 - iii. The 640-character backlit LCD display shall indicate all information associated with the trouble condition, including the type of trouble point and its location within the protected premises.
 - iv. Printing and history storage equipment shall log and print the event information along with a time and date stamp.
 - v. All system outputs assigned via preprogrammed equations for a particular point in trouble shall be executed, and the associated system outputs (trouble notification appliances and/or relays) shall be activated.

- 6. When a supervisory condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:
 - a. The system supervisory LED shall flash.
 - b. A local piezo-electric audible device in the control panel shall sound a distinctive signal.
 - c. The 640-character backlit LCD display shall indicate all information associated with the supervisory condition, including the type of trouble point and its location within the protected premises.
 - d. Printing and history storage equipment shall log and print the event information along with a time and date stamp.
 - e. All system outputs assigned via preprogrammed equations for a particular point in trouble shall be executed, and the associated system outputs (notification appliances and/or relays) shall be activated.
- C. Operator Control:
 - 1. Acknowledge Switch:
 - a. Activation of the control panel acknowledge switch in response to new alarms and/or troubles shall silence the local panel piezo electric signal and change the alarm and trouble LEDs from flashing mode to steady-ON mode. If multiple alarm or trouble conditions exist, depression of this switch shall advance the LCD display to the next alarm or trouble condition. In addition, the FACP shall support Block Acknowledge to allow multiple trouble conditions to be acknowledged with a single depression of this switch.
 - b. Depression of the Acknowledge switch shall also silence all remote annunciator piezo sounders.
 - 2. Signal Silence Switch:
 - a. Depression of the Signal Silence switch shall cause all programmed alarm notification appliances and relays to return to the normal condition. The selection of notification circuits and relays that are silence able by this switch shall be fully field programmable within the confines of all applicable standards. The FACP software shall include silence inhibit and auto-silence timers.
 - 3. Drill Switch:
 - a. Depression of the Drill switch shall activate all programmed notification appliance circuits. The drill function shall latch until the panel is silenced or reset.
 - 4. System Reset Switch:
 - a. Depression of the System Reset switch shall cause all electronically latched initiating devices to return to their normal condition. Initiating devices shall re-report if active. Active notification appliance circuits shall not silence upon Reset. Systems that deactivate and subsequently re-activate notification appliance circuits shall not be considered equal. All programmed Control-By-Event equations shall be re-evaluated

after the reset sequence is complete if the initiating condition has cleared. Non-latching trouble conditions shall not clear and re-report upon reset.

- 5. Lamp Test:
 - a. The Lamp Test switch shall activate all local system LEDs, light each segment of the liquid crystal display and display the panel software revision for service personal.
- 6. Scroll Display Keys:
 - a. There shall be Scroll Display keys for FIRE ALARM, SECURITY, SUPERVISORY, TROUBLE, and OTHER EVENTS. Depression of the Scroll Display key shall display the next event in the selected queue allowing the operator to view events by type.
- 7. Print Screen:
 - a. Depression of the PRINT SCREEN switch shall send the information currently displayed on the 640-character display to the printer.
- D. System Capacity and General Operation:
 - Controls panel shall be equipped with 10 SLC modules, regardless of if final design required less. Each module shall support a maximum of 318 analog/ addressable devices for a maximum system capacity of 3180 points. The system shall be capable of 3072 annunciation points per system regardless of the number of addressable devices and shall support up to 96 panel circuits which may consist of either inputs or outputs.
 - 2. The Fire Alarm Control Panel shall include a full featured operator interface control and annunciation panel that shall include a backlit 640-character liquid crystal display, individual, color coded system status LEDs, and a QWERTY style alphanumeric keypad for the field programming and control of the fire alarm system. Said LCD shall also support graphic bit maps capable of displaying the company name and logo of either the owner or installing company.
 - 3. All programming or editing of the existing program in the system shall be achieved without special equipment and without interrupting the alarm monitoring functions of the fire alarm control panel.
 - 4. The FACP shall be able to provide the following software and hardware features:
 - a. The system shall support a detector response time to meet world annunciation requirements of less than 3 seconds.
 - b. Device Blink Control: Means shall be provided to turn off detector/module LED strobes for special areas.
 - c. NFPA 72 Smoke Detector Sensitivity Test: The system shall provide an automatic smoke detector test function that meet the requirements of NFPA 72, 2010 Edition
 - d. Programmable Trouble Reminder: The system shall provide means to automatically initiate a reminder that troubles exist in the system. The reminder will appear on the system display and (if enabled) will sound a piezo alarm.

- e. On-line or Off-line programming: The system shall provide means to allow panel programming either through an off-line software utility program away from the panel or while connected and on-line. The system shall also support upload and download of programmed database and panel executive system program to a Personal Computer/laptop.
- f. History Events: The panel shall maintain a history file of the last 4000 events, each with a time and date stamp. History events shall include all alarms, troubles, operator actions, and programming entries. The control panels shall also maintain a 1000 event Alarm History buffer, which consists of the 1000 most recent alarm events from the 4000 event history file.
- g. Smoke Control Modes: The system shall provide means to perform FSCS mode Smoke Control to meet NFPA-92A, 2000 Edition and 90B, 2002 Edition and HVAC mode to meet NFPA 90A, 2012 Edition.
- h. The system shall provide means for all SLC devices on any SLC loop to be auto programmed into the system by specific address. The system shall recognize specific device type ID's and associate that ID with the corresponding address of the device.
- i. Drill: The system shall support means to activate all silencable fire output circuits in the event of a practice evacuation or "drill". If enabled for local control, the front panel switch shall be held for a minimum of 2 seconds prior to activating the drill function.
- j. Passwords and Users: The system shall support two password levels, master and user. Up to 9 user passwords shall be available, each of which may be assigned access to the programming change menus, the alter status menus, or both. Only the master password shall allow access to password change screens.
- k. Block Acknowledge: The system shall support a block Acknowledge for Trouble Conditions.
- I. Sensitivity Adjust: The system shall provide Automatic Detector Sensitivity Adjust based on Occupancy schedules including a Holiday list of up to 15 days.
- m. Environmental Drift Control: The system shall provide means for setting Environmental Drift Compensation by device. When a detector accumulates dust in the chamber and reaches an unacceptable level but yet still below the allowed limit, the control panel shall indicate a maintenance alert warning. When the detector accumulates dust in the chamber above the allowed limit, the control panel shall indicate a maintenance urgent warning.
- n. Custom Action Messages: The system shall provide means to enter up to 100 custom action messages of up to 160 characters each. It shall be possible to assign any of the 100 messages to any point.

- o. Print Functions: The system shall provide means to obtain a variety of reports listing all event, alarm, trouble, supervisory, or security history. Additional reports shall be available for point activation for the last Walk Test performed, detector maintenance report containing the detector maintenance status of each installed addressable detector, all network parameters, all panel settings including broad cast time, event ordering, and block acknowledge, panel timer values for Auto Silence, Silence Inhibit, AC Fail Delay time and if enabled, Proprietary Reminder, and Remote Reminder timers, supervision settings for power supply and printers, all programmed logic equations, all custom action messages, all non-fire and output activations (if pre-programmed for logging) all active points filtered by alarms only, troubles only, supervisory alarms, pre-alarms, disabled points and activated points, all installed points filtered by SLC points, panel circuits, logic zones, annunicators, releasing zones, special zones, and trouble zones.
- p. Local Mode: If communication is lost to the central processor the system shall provide added survivability through the intelligent loop control modules. Inputs from devices connected to the SLC and loop control modules shall activate outputs on the same loop when the inputs and outputs have been set with point programming to participate in local mode or when the type codes are of the same type: that is, an input with a fir alarm type code shall activate an output with a fire alarm type code.
- q. Resound based on type for security or supervisory: The system shall indicate a Security alarm when a monitor module point programmed with a security Type Code activates. If silenced alarms exist, a Security alarm will resound the panel sounder. The system shall indicate a Supervisory alarm when a monitor module point programmed with a supervisory Type Code activates. If there are silenced alarms, a Supervisory alarm will resound the panel sounder.
- r. Read status preview enabled and disabled points: Prior to re-enabling points, the system shall inform the user that a disabled device is in the alarm state. This shall provide notice that the device must be reset before the device is enabled thereby avoiding activation of the notification circuits.
- s. Custom Graphics: When fitted with an LCD display, the panel shall permit uploading of a custom bit-mapped graphic to the display screen.
- t. Multi-Detector and Cooperating Detectors: The system shall provide means to link one detector to up to two detectors at other addresses on the same loop in cooperative multi-detector sensing. There shall be no requirement for sequential addresses on the detectors and the alarm event shall be a result or product of all cooperating detectors chamber readings.
- u. Tracking/Latching Duct (ion and photo): The system shall support both tracking and latching duct detectors either ion or photo types.
- v. ACTIVE EVENT: The system shall provide a Type ID called FIRE CONTROL for purposes of air-handling shutdown, which shall be intended to override normal operating automatic functions. Activation of a FIRE CONTROL point shall cause the control panel to (1) initiate the monitor module Control-by-Event, (2) send a message to the panel display, history buffer, installed printer and annunciators, (3) shall not light an indicator at the control panel, (4) Shall display ACTIVE on the LCD as well a display a FIRE CONTROL Type Code and other information specific to the device.

- w. NON-FIRE Alarm Module Reporting: A point with a type ID of NON-FIRE shall be available for use for energy management or other non-fire situations. NON-FIRE point operation shall not affect control panel operation nor shall it display a message at the panel LDC. Activation of a NON-FIRE point shall activate control by event logic but shall not cause any indication on the control panel.
- x. Security Monitor Points: The system shall provide means to monitor any point as a type security.
- y. One-Man Walk Test: The system shall provide both a basic and advanced walk test for testing the entire fire alarm system. The basic walk test shall allow a single operator to run audible tests on the panel. All logic equation automation shall be suspended during the test and while annunciators can be enabled for the test, all shall default to the disabled state. During an advanced walk test, field-supplied output point programming will react to input stimuli such as CBE and logic equations. When points are activated in advanced test mode, each initiating event shall latch the input. The advanced test shall be audible and shall be used for pull station verification, magnet activated tests on input devices, input and output device and wiring operation/verification.
- z. Control By Event Functions: CBE software functions shall provide means to program a variety of output responses based on various initiating events. The control panel shall operate CBE through lists of zones. A zone shall become listed when it is added to a point's zone map through point programming. Each input point such as detector, monitor module or panel circuit module shall support listing of up to 10 zones into its programmed zone map.
- aa. Permitted zone types shall be general zone, releasing zone and special zone. Each output point (control module, panel circuit module) can support a list of up to 10 zones including general zone, logic zone, releasing zone and trouble zone. It shall be possible for output points to be assigned to list general alarm. Non-Alarm or Supervisory points shall not activate the general alarm zone.
- bb. 1000 General Zones: The system shall support up to 1000 general purpose software zones for linking inputs to outputs. When an input device activates, any general zone programmed into that device's zone map will be active and any output device that has an active general zone in its map will be active. It shall also be possible to use general zone as arguments in logic equations.
- cc. 1000 Logic Equations: The system shall support up to 1000 logic equations for AND, OR, NOT, ONLY1, ANYX, XZONE or RANGE operators that allow conditional I/O linking. When any logic equation becomes true, all output points mapped to the logic zone shall activate.
- dd. 10 trouble equations per device: The system shall provide support for up to 10 trouble equations for each device, which shall permit programming parameters to be altered, based on specific fault conditions. If the trouble equation becomes true, all output points mapped to the trouble zone shall activate.
- ee. Control-By-Time: A time based logic function shall be available to delay an action for a specific period of time based upon a logic input with tracking feature. A latched version shall also be available. Another version of this shall permit activation on specific days of the week or year with ability to set and restore based on a 24 hour time schedule on any day of the week or year.

- ff. Multiple agent releasing zones: The system shall support up to 10 releasing zones to protect against 10 independent hazards. Releasing zones shall provide up to three cross-zone with four abort options to satisfy any local jurisdiction requirements.
- E. Central Processing Unit:
 - 1. The Central Processing Unit shall communicate with, monitor, and control all other modules within the control panel. Removal, disconnection or failure of any control panel module shall be detected and reported to the system display by the Central Processing Unit.
 - 2. The Central Processing Unit shall contain and execute all control-by-event (including Boolean functions including but not limited to AND, OR, NOT, ANYx, and CROSSZONE) programs for specific action to be taken if an alarm condition is detected by the system. Such control-by-event programs shall be held in non-volatile programmable memory, and shall not be lost with system primary and secondary power failure.
 - 3. The Central Processing Unit shall also provide a real-time clock for time annotation, to the second, of all system events. The time-of-day and date shall not be lost if system primary and secondary power supplies fail.
 - 4. The CPU shall be capable of being programmed on site without requiring the use of any external programming equipment. Systems that require the use of external programmers or change of EPROMs are not acceptable.
 - 5. Consistent with UL864 standards, the CPU and associated equipment are to be protected so that voltage surges or line transients will not affect them.
 - 6. Each peripheral device connected to the CPU shall be continuously scanned for proper operation. Data transmissions between the CPU and peripheral devices shall be reliable and error free. The transmission scheme used shall employ dual transmission or other equivalent error checking techniques.
 - 7. The CPU shall provide an EIA-232 interface between the fire alarm control panel and the UL Listed Electronic Data Processing (EDP) peripherals.
 - 8. The CPU shall provide two EIA-485 ports for the serial connection to annunciation and control subsystem components.
 - 9. The EIA-232 serial output circuit shall be optically isolated to assure protection from earth ground.
 - 10. The CPU shall provide one high-speed serial connection for support of network communication modules.
 - 11. The CPU shall provide double pole relays for FIRE ALARM, SYSTEM TROUBLE, SUPERVISORY, and SECURITY. The SUPERVISORY and SECURITY relays shall provide selection for additional FIRE ALARM contacts.
- F. Display:
 - 1. The system display shall provide all the controls and indicators used by the system operator and may also be used to program all system operational parameters.
 - 2. The display assembly shall contain, and display as required, custom alphanumeric labels for all intelligent detectors, addressable modules, and software zones.

- The system display shall provide a 640-character backlit alphanumeric Liquid Crystal Display (LCD). It shall also provide ten Light-Emitting-Diodes (LEDs) that indicate the status of the following system parameters: AC POWER, FIRE ALARM, PREALARM, SECURITY, SUPERVISORY, SYSTEM TROUBLE, OTHER EVENT, SIGNALS SILENCED, POINT DISABLED, and CPU FAILURE.
- 4. The system display shall provide a QWERTY style keypad with control capability to command all system functions, entry of any alphabetic or numeric information, and field programming. Two different password levels with up to ten (one Master and nine User) passwords shall be accessible through the display interface assembly to prevent unauthorized system control or programming.
- 5. The system display shall include the following operator control switches: ACKNOWLEDGE, SIGNAL SILENCE, RESET, DRILL, and LAMP TEST. Additionally, the display interface shall allow scrolling of events by event type including, FIRE ALARM, SECURITY, SUPERVISORY, TROUBLE, and OTHER EVENTS. A PRINT SCREEN button shall be provided for printing the event currently displayed on the 640-character LCD.
- G. Loop (Signaling Line Circuit) Control Module:
 - 1. The Loop Control Module shall monitor and control a minimum of 318 intelligent addressable devices. This includes 159 intelligent detectors (Ionization, Photoelectric, or Thermal) and 159 monitor or control modules.
 - 2. The Loop Control Module shall contain its own microprocessor and shall be capable of operating in a local/degrade mode (any addressable device input shall be capable of activating any or all addressable device outputs) in the unlikely event of a failure in the main CPU.
 - 3. The Loop Control Module shall provide power and communicate with all intelligent addressable detectors and modules on a single pair of wires. This SLC Loop shall be capable of operating as a NFPA Style 6 (Class B) circuit.
 - 4. The SLC interface board shall be able to drive an NFPA Style 6 twisted shielded circuit up to 12,500 feet in length. The SLC Interface shall also be capable of driving an NFPA Style 6, no twist, no shield circuit up to 3,000 feet in length. In addition, SLC wiring shall meet the listing requirements for it to exit the building or structure.
 - 5. The SLC interface board shall receive analog or digital information from all intelligent detectors and shall process this information to determine whether normal, alarm, or trouble conditions exist for that particular device. Each SLC Loop shall be isolated and equipped to annunciate an Earth Fault condition. The SLC interface board software shall include software to automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. The analog information may also be used for automatic detector testing and the automatic determination of detector maintenance requirements.
- H. Enclosures:
 - 1. The control panel shall be housed in a UL-listed cabinet suitable for surface or semi-flush mounting. The cabinet and front shall be corrosion protected, given a rust-resistant prime coat, and manufacturer's standard finish.

- 2. The back box and door shall be constructed of 0.060 steel with provisions for electrical conduit connections into the sides and top.
- The door shall provide a key lock and include a transparent opening for viewing all indicators. For convenience, the door shall have the ability to be hinged on either the right or left-hand side.
- 4. The control unit shall be modular in structure for ease of installation, maintenance, and future expansion.
- I. Digital Voice Command Center (DVC):
 - 1. The Digital Voice Command Center (DVC) shall contain all equipment required for all audio control, telephone system control, signaling and supervisory functions. This shall include speaker zone indication and control telephone circuit indication and control, digital voice units, microphone and main telephone handset.
 - 2. Function: The Voice Command Center equipment shall perform the following functions:
 - a. Operate as a supervised multi-channel emergency voice communication system.
 - b. Operate as a two-way emergency telephone system control center.
 - c. Audibly and visually annunciate the active or trouble condition of every speaker circuit and emergency telephone circuit.
 - d. Audibly and visually annunciate any trouble condition for digital tone and voice units required for normal operation of the system.
 - e. Provide all-call Emergency Paging activities through activation of a single control switch.
 - f. As required, provide vectored paging control to specific audio zones via dedicated control switches.
 - g. Provide a factory recorded "library" of voice messages and tones in standard WAV. File format, which may be edited and saved on a PC running a current Windows® operating system.
 - h. Provide a software utility capable of off-line programming for the VCC operation and the audio message files. This utility shall support the creation of new programs as well as editing and saving existing program files. Uploading or downloading the VCC shall not inhibit the emergency operation of other nodes on the fire alarm network.
 - i. The Digital Voice Command shall be modular in construction, and shall be capable of being field programmable without requiring the return of any components to the manufacturer and without requiring use of any external computers or other programming equipment.
 - j. The Digital Voice Command and associated equipment shall be protected against unusually high voltage surges or line transients.
 - 2. Control Selection of the fire fighter's telephone circuits and voice evacuation speaker circuits throughout the project shall have local control at the DVC panel in which the circuit audio source is generated. DVC equipment in each location shall be provided with sufficient selector buttons to accommodate quantity of circuits required.

J. Power Supply:

- 1. The Addressable Main Power Supply shall operate on 120/240 VAC, 50/60 Hz, and shall provide all necessary power for the FACP.
- 2. The Addressable Main Power Supply shall provide 9 amps of power to the CPU, using a switching 24 VDC regulator and shall incorporate a battery charger for 4 hours of standby power using dual-rate charging techniques for fast battery recharge.
- 3. The Addressable Main Power Supply shall provide a battery charger for 4 hours of standby using dual-rate charging techniques for fast battery recharge. The supply shall be capable of charging batteries ranging in capacity from 25-200 amp-hours within a 48-hour period.
- 4. The Addressable Main Power Supply shall provide a very low frequency sweep earth detect circuit, capable of detecting earth faults.
- 5. The Addressable Main Power Supply shall be power-limited per 1995 UL864 requirements.
- K. Field Charging Power Supply (FCPS): The FCPS is a device designed for use as either a remote 24 volt power supply or used to power Notification Appliances.
 - 1. The FCPS shall be rated 8.0 amps (6.0 amps continuous) of regulated 24-volt power. It shall include an integral charger designed to charge 7.0 amp hour batteries and to support 24-hour standby. Use of 6.0 amp power supplies is not permitted.
 - 2. The Field Charging Power Supply shall have two input triggers. The input trigger shall be a Notification Appliance Circuit (from the fire alarm control panel) or a relay. Four outputs (two Style Y or Z and two style Y) shall be available for connection to the Notification devices.
 - 3. The FCPS shall include an attractive surface mount backbox.
 - 4. The Field Charging Power Supply shall include the ability to delay the AC fail delay per NFPA requirements.
 - 5. The FCPS include power limited circuitry, per 1995 UL standards.
 - 6. Provide minimum of (2) FCPS per notification zone, as indicated on drawings, to support survivability design. (1) FCPS shall be dedicated to 24V power applications only, and the second (or multiple others) shall be dedicated to notification circuits. 24V power and notification circuits shall not be derived from the same FCPS. Circuits from FCPS shall be dedicated to the notification zone in which it is located, and shall not serve other areas unless specifically noted otherwise.
- L. System Circuit Supervision:
 - The FACP shall supervise all circuits to intelligent devices, amplifiers, annunciators and peripheral equipment and annunciate loss of communications with these devices. The CPU shall continuously scan above devices for proper system operation and upon loss of response from a device shall sound an audible trouble, indicate which device or devices are not responding and print the information in the history buffer and on the printer.
 - 2. Equipment that loses communication with the CPU shall sound an audible trouble and light an LED indicating loss of communications.

- 3. Sprinkler system valves, standpipe control valves, PIV, and main gate valves shall be supervised for off-normal position.
- 4. All speaker and emergency phone circuits shall be supervised for opens and shorts. Each transponder speaker and emergency phone circuit shall have an individual ON/OFF indication (green LED).
- N. Field Wiring Terminal Blocks:
 - 1. All wiring terminal blocks shall be the plug-in/removable type and shall be capable of terminating up to 12 AWG wire. Terminal blocks that are permanently fixed to the PC board are not acceptable.
- O. Digital Audio Amplifiers:
 - 1. The Digital Audio Amplifiers (FDAA2) will provide Audio Power (@25 Volts RMS) for distribution to speaker circuits.
 - 2. Provide minimum of (1) FDAA per notification zone, as indicated on drawings, to support survivability design. Circuits from FDAA shall be dedicated to the notification zone in which it is located, and shall not serve other areas unless specifically noted otherwise.
 - 3. The audio amplifier shall include an integral power supply, and shall provide built-in LED indicators for the following conditions:
 - a. Earth Fault on DAP A (Digital Audio Port A)
 - b. Earth Fault on DAP B (Digital Audio Port B)
 - c. Audio Amplifier Failure Detected Trouble
 - d. Active Alarm Bus input
 - e. Audio Detected on Aux Input A
 - f. Audio Detected on Aux Input B
 - g. Audio Detected on Firefighter's Telephone Riser
 - h. Receiving Audio from digital audio riser
 - i. Short circuit on speaker circuit 1
 - j. Short circuit on speaker circuit 2
 - k. Short circuit on speaker circuit 3
 - I. Short circuit on speaker circuit 4
 - m. Data Transmitted on DAP A
 - n. Data Received on DAP A
 - o. Data Transmitted on DAP B
 - p. Data Received on DAP B
 - q. Board failure
 - r. Active fiber optic media connection on port A (fiber optic media applications)
 - s. Active fiber optic media connection on port B (fiber optic media applications)
 - t. Power supply Earth Fault
 - u. Power supply 5V present
 - v. Power supply conditions Brownout, High Battery, Low Battery, Charger Trouble
 - 4. The audio amplifier shall provide the following built-in controls:
 - a. Amplifier Address Selection Switches
 - b. Signal Silence of communication loss annunciation Reset
 - c. Level adjustment for background music
 - d. Enable/Disable for Earth Fault detection on DAP A
 - e. Enable/Disable for Earth Fault detection on DAP A

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 121505 Addressable Fire Alarm System Section 28 3111 - 17

- f. Switch for 2-wire/4-wire FFT riser
- 5. Adjustment of the correct audio level for the amplifier shall not require any special tools or test equipment.
- 6. Includes audio input and amplified output supervision, back up input, and automatic switch over function, (if primary amplifier should fail).
- 7. System shall be capable of backing up digital amplifiers.
- P. Audio Message Generator (Prerecorded Voice)/Speaker Control:
 - 1. Each initiating zone or intelligent device shall interface with an emergency voice communication system capable of transmitting a prerecorded voice message to all speakers in the building.
 - 2. Actuation of any alarm initiating device shall cause a prerecorded message to sound over the speakers. The message shall be repeated four (4) times.
 - 3. A built-in microphone shall be provided to allow paging through speaker circuits.
 - 4. System paging from emergency telephone circuits shall be supported.
 - 5. The audio message generator shall have the following controls and LED indicators to allow for proper operator understanding and control:
 - a. Lamp Test
 - b. Trouble
 - c. Off-Line Trouble
 - d. Microphone Trouble
 - e. Phone Trouble
 - f. Busy/Wait
 - g. Page Inhibited
 - h. Pre/Post Announcement Tone
- Q. Controls with associated LED Indicators:
 - 1. Speaker Switches/Indicators
 - a. The speaker circuit control switches/indicators shall include visual indication of active and trouble status for each speaker circuit in the system.
 - b. The speaker circuit control panel shall include switches to manually activate or deactivate each speaker circuit in the system.
- R. Remote Transmissions:
 - 1. Provide local energy or polarity reversal or trip circuits as required.
 - 2. The system shall be capable of operating a polarity reversal or local energy or fire alarm transmitter for automatically transmitting fire information to the fire department.
 - 3. Provide capability and equipment for transmission of zone alarm and trouble signals to remote operator's terminals, system printers and annunciators.

- 4. Transmitters shall be compatible with the systems and equipment they are connected to such as timing, operation and other required features.
- S. System Expansion: Design the main FACP so that the system can be expanded in the future (to include the addition of twenty percent more circuits or zones up to capacity of quantity of control panels indicated) without disruption or replacement of the existing control panel. This shall include hardware capacity, software capacity and cabinet space.
- T. Field Programming:
 - 1. The system shall be programmable, configurable and expandable in the field without the need for special tools, laptop computers, or other electronic interface equipment. There shall be no firmware changes required to field modify the system time, point information, equations, or annunciator programming/information.
 - 2. It shall be possible to program through the standard FACP keyboard all system functions.
 - 3. All field defined programs shall be stored in non-volatile memory.
 - 4. Two levels of password protection shall be provided in addition to a key-lock cabinet. One level shall be used for status level changes such as point/zone disable or manual on/off commands (Building Manager). A second (higher-level) shall be used for actual change of the life safety program (installer). These passwords shall be five (5) digits at a minimum. Upon entry of an invalid password for the third time within a one minute time period an encrypted number shall be displayed. This number can be used as a reference for determining a forgotten password.
 - 5. The system programming shall be "backed" up on a CD/DVD disc utilizing an upload/download program. This system back-up disk shall be completed and given in duplicate to the building owner and/or operator upon completion of the final inspection. The program that performs this function shall be "non-proprietary", in that, it shall be possible to forward it to the building owner/operator upon his or her request.
 - U. The installer's field programming and hardware shall be functionally tested on a computer against known parameters/norms which are established by the FACP manufacturer. A software program shall test Input-to-Output correlations, device Type ID associations, point associations, time equations, etc. This test shall be performed on an IBM-compatible PC with a verification software package. A report shall be generated of the test results and two copies turned in to the engineer(s) on record.
 - V. Specific System Operations: Smoke Detector Sensitivity Adjust: Means shall be provided for adjusting the sensitivity of any or all analog intelligent smoke detectors in the system from the system keypad or from the keyboard of the video terminal. Sensitivity range shall be within the allowed UL window.
 - W. System Point Operations:
 - 1. Any addressable device in the system shall have the capability to be enabled or disabled through the system keypad or video terminal.
 - 2. System output points shall be capable of being turned on or off from the system keypad or the video terminal.

- 3. Point Read: The system shall be able to display the following point status diagnostic functions without the need for peripheral equipment. Each point shall be annunciated for the parameters listed:
 - a. Device Status.
 - b. Device Type.
 - c. Custom Device Label.
 - d. Software Zone Label.
 - e. Device Zone Assignments.
 - f. Analog Detector Sensitivity.
 - g. All Program Parameters.
- 4. System Status Reports: Upon command from an operator of the system, a status report will be generated and printed, listing all system statuses.
- 5. System History Recording and Reporting: The fire alarm control panel shall contain a history buffer that will be capable of storing up to 4000 system events. Each of these events will be stored, with time and date stamp, until an operator requests that the contents be either displayed or printed. The contents of the history buffer may be manually reviewed; one event at a time and the actual number of activations may also be displayed and or printed. History events shall include all alarms, troubles, operator actions, and programming entries.
- 6. The history buffer shall use non-volatile memory. Systems which use volatile memory for history storage are not acceptable.
- 7. Automatic Detector Maintenance Alert: The fire alarm control panel shall automatically interrogate each intelligent system detector and shall analyze the detector responses over a period of time.
- 8. If any intelligent detector in the system responds with a reading that is below or above normal limits, then the system will enter the trouble mode, and the particular Intelligent Detector will be annunciated on the system display, and printed on the optional system printer. This feature shall in no way inhibit the receipt of alarm conditions in the system, nor shall it require any special hardware, special tools or computer expertise to perform.
- The system shall include the ability (programmable) to indicate a "pre-alarm" condition. This
 will be used to alert maintenance personal when a detector is at 80% of its alarm threshold in
 a 60 second period.

2.3 SYSTEM COMPONENTS

- A. Visual Strobe Lights: Devices shall meet the requirements of the ADA, UL Standard 1971, be fully synchronized, and shall meet the following criteria:
 - 1. The maximum pulse duration shall be 2/10 of one second.
 - 2. Strobe intensity shall meet the requirements of UL 1971. Minimum candela rating shall be 75cd, unless noted otherwise.
 - 3. The flash rate shall meet the requirements of UL 1971.
 - 4. Devices shall be Red.
 - 5. Manufacturer: System Sensor SpectraAlert Advance (No substitutions).
- B. Speakers:
 - 1. All speakers shall operate on 25 VRMS or with field selectable output taps from 0.5 to 2.0 Watts.

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 121505 Addressable Fire Alarm System Section 28 3111 - 20

- 2. Speakers in corridors and public spaces shall produce a nominal sound output of 84 dBA at 10 feet (3m).
- 3. Frequency response shall be a minimum of 400 HZ to 4000 HZ.
- 4. The back of each speaker shall be sealed to protect the speaker cone from damage and dust.
- 5. Manufacturer: System Sensor SpectraAlert Advance (No substitutions).
- C. Combination Visual/Audible Devices: Shall comply with both section 2.4-A and 2.4-B above.
- D. Central Station Communications: Communications with the 3rd-party UL listed central station shall be via Service-provided Radio or Cellular Dialer system and account.
 - 1. Communication shall include vital system status such as:
 - a. Independent Zone (Alarm, trouble, non-alarm, supervisory)
 - b. Independent Addressable Device Status
 - c. AC (Mains) Power Loss
 - d. Low Battery and Earth Fault
 - e. System Off Normal
 - f. 12 and 24 Hour Test Signal
 - g. Abnormal Test Signal (per UL requirements)
 - h. EIA-485 Communications Failure

2.5 SYSTEM COMPONENTS - ADDRESSABLE DEVICES

- A. Addressable Devices General:
 - 1. Addressable devices shall provide an address-setting means using rotary decimal switches.
 - 2. Addressable devices shall use simple to install and maintain decade (numbered 0 to 9) type address switches. Devices which use a binary address or special tools for setting the device address, such as a dip switch are not an allowable substitute.
 - 3. Detectors shall be Analog and Addressable, and shall connect to the fire alarm control panel's Signaling Line Circuits.
 - 4. Addressable smoke and thermal detectors shall provide dual (2) status LEDs. Both LEDs shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel, and both LEDs shall be placed into steady illumination by the control panel, indicating that an alarm condition has been detected. If required, the flashing mode operation of the detector LEDs can be programmed off via the fire control panel program.
 - The fire alarm control panel shall permit detector sensitivity adjustment through field programming of the system. Sensitivity can be automatically adjusted by the panel on a timeof-day basis.
 - 6. Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72, Chapter 7.
 - 7. The detectors shall be ceiling-mount and shall include a separate twist-lock base which includes a tamper proof feature.

- 8. The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.
- 9. Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device (ION, PHOTO, THERMAL).
- B. Addressable Manual Fire Alarm Box (manual station):
 - 1. Addressable pull boxes shall, on command from the control panel, send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
 - 2. All operated stations shall have a positive, visual indication of operation and utilize a key type reset.
 - 3. Manual stations shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 1.75 inches (44 mm) or larger.
 - 4. Devices shall be red.
- C. Intelligent Photoelectric Smoke Detector:
 - 1. The detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.
- D. Intelligent Thermal Detectors:
 - Thermal detectors shall be intelligent addressable devices rated at 135 degrees Fahrenheit (58 degrees Celsius) and have a rate-of-rise element rated at 15 degrees F (9.4 degrees C) per minute. It shall connect via two wires to the fire alarm control panel signaling line circuit.
- E. Intelligent Duct Smoke Detector:
 - 1. The smoke detector housing shall accommodate an intelligent photoelectric of that provides continuous analog monitoring and alarm verification from the panel.
 - 2. When sufficient smoke is sensed, an alarm signal is initiated at the FACP, and appropriate action taken to change over air handling systems to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system.
 - 3. All duct detectors installed in concealed locations, i.e. above ceiling assemblies or requiring vertical access (ladder) shall be provided with a remote indicating and test switch located in the adjacent corridor ceiling. Identify device address and HVAC equipment name via "croix" label for each device.
- F. Addressable Dry Contact Monitor Module:
 - Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device) to one of the fire alarm control panel SLCs.

- 2. The monitor module shall mount in a 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep electrical box.
- 3. The IDC zone shall be suitable for Style D or Style B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.
- G. Addressable Control Module:
 - 1. Addressable control modules shall be provided to supervise and control the operation of one conventional NACs of compatible, 24 VDC powered, polarized audio/visual notification appliances.
 - The control module shall mount in a standard 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep electrical box, or to a surface mounted backbox.
 - 3. The control module NAC may be wired for Style Z or Style Y (Class A/B) with up to 1 amp of inductive A/V signal, or 2 amps of resistive A/V signal operation, or as a dry contact (Form-C) relay. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.
 - 4. Audio/visual power shall be provided by a separate supervised power circuit from the main fire alarm control panel or from a supervised, UL listed remote power supply.
 - 5. The control module shall be suitable for pilot duty applications and rated for a minimum of 0.6 amps at 30 VDC.
- H. Addressable Relay Module:
 - Addressable Relay Modules shall be available for HVAC control and other building functions. The relay shall be form C and rated for a minimum of 2.0 Amps resistive or 1.0 Amps inductive. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.
 - 2. For fan shutdown and other auxiliary control functions requiring the control of 24V AC power, utilize the addressable relay module directly for the switching function.
 - 3. For fan shutdown and other auxiliary control functions requiring the control of greater than 24V AC Power (such as 120V AC power), provide an MR101 (or MR201 as specified on drawings) auxiliary relay for the switching/control function. Utilize the addressable relay module with 24VDC power from the fire alarm system as a dry contract relay to control the 24VDC coil associated with the MR101/201 relay.
 - a. Application includes interface with elevator controllers for phase 1 recall.
 - 4. Where required, install module in finished ceiling to allow for clear view of LED indicating lamp. Do not install modules above finished ceilings or at inaccessible locations.
- J. Isolator Module:
 - 1. Isolator modules shall be provided to automatically isolate wire-to-wire short circuits on an SLC Class A or Class B branch. The isolator module shall limit the number of modules or

detectors that may be rendered inoperative by a short circuit fault on the SLC loop segment or branch. At least one isolator module shall be provided at the entrance and exit of an SLC circuit for each smoke compartment or zone served. Refer to plans for additional isolator module locations.

- 2. If a wire-to-wire short occurs, the isolator module shall automatically open-circuit (disconnect) the SLC. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.
- 3. The isolator module shall not require address-setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation.
- The isolator module shall provide a single LED that shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.

2.6 BATTERIES AND EXTERNAL CHARGER

- A. Battery:
 - 1. Shall be 12 volt, Gell-Cell type.
 - 2. Battery shall have sufficient capacity to power the fire alarm system for not less than twentyfour hours plus 15 minutes of alarm upon a normal AC power failure.
 - 3. The batteries are to be completely maintenance free. No liquids are required. Fluid level checks refilling, spills and leakage shall not be required.
 - 4. All battery installations shall be dated with the actual date of installation only. Do not use the date of final inspection or system approval.
- B. External Battery Charger:
 - 1. Shall be completely automatic, with constant potential charger maintaining the battery fully charged under all service conditions. Charger shall operate from a 120/240-volt 50/60 hertz source.
 - 2. Shall be rated for fully charging a completely discharged battery within 48 hours while simultaneously supplying any loads connected to the battery.
 - 3. Shall have protection to prevent discharge through the charger.
 - 4. Shall have protection for overloads and short circuits on both AC and DC sides.

2.7 ELECTROMAGNETIC HOLD-OPEN DEVICES

- A. Electromagnetic Doorholders:
 - Provide local disconnecting means for all 120VAC connected door holders via toggle switch with protective RS cover to prevent inadvertent release of circuit. Locate (1) disconnect switch for each pair of doors connected. Locate disconnect switch above nearest accessible ceiling to door location and clearly label switch with croix label with the following description "Door Holder Disconnect".

PART 3 - EXECUTION

3.1 GENERAL

- A. Workmanship: The entire system shall be installed in a skillful manner in accordance with approved manufacturers' manuals and wiring diagrams. The contractor shall provide all raceway, wiring, outlet boxes, junction boxes, cabinets and similar devices necessary for the complete installation. All wiring and raceway shall be provided in accordance with the NEC, approved by local authorities having jurisdiction for the purpose, and shall be installed in dedicated metal raceway system throughout.
- B. Penetrations: All penetration of floor slabs and fire walls shall be fire stopped in accordance with all local fire codes.
- C. Resistors: End of Line Resistors shall be furnished as required for mounting as directed by the manufacturer.
- D. Installation: Provide all raceways, cable, equipment, accessories and materials as detailed in the manufacturers' installation manual and require for the satisfactory operation of the fire alarm system, the elevator detection system, mechanical systems control, and the interface between components and systems.
- E. Mounting Heights:
 - 1. Install manual pull stations 48" AFF to center line of device.
 - 2. Wall mounted notification appliances shall be located 80-inches (minimum) above the finished floor or 6-inches below ceiling to the bottom of the lens.
 - 3. Mounting Height: Mount remote alarm indicators in finished ceiling.
 - 4. In finished areas, install all fire alarm modules in finished ceiling to allow for clear view of LED indicating lamp. Do not install modules above finished ceilings or at inaccessible locations.
- F. Device Naming Convention:
 - 1. Contractor shall coordinate all device naming conventions, for both addressable and notification devices, with FH Controls Systems Division prior to any application or system programming. Submit in writing to FH Controls Systems Division a summary of all devices and proposed device identifications for review, comment and approval.
 - 2. Contractor shall identify on each device the approved device identification via "croix" label.
- **3.2** PRODUCT STORAGE AND HANDLING
 - A. Protection: Physically protect smoke and heat detectors against damage as recommended by manufacturer. Minimize exposure of detectors to dirt and dust from construction. Provide plastic covers during construction. Remove covers after the project has been cleaned and is ready for operation. Testing must be done after the removal of protective covers.
 - B. Packaging: Store equipment in original packaging. Store inside well ventilated area protected from weather, moisture, dust, extreme temperatures, and humidity.

C. Damage: Remove and replace with new, all broken pull stations, detectors, annunciation devices and other accessories, damaged before final acceptance at no additional expense to the contract. No allowances shall be made for breakage or theft before final acceptance.

3.3 CONDUIT AND WIRE

- A. Conduit:
 - 1. Conduit shall be in accordance with The National Electrical Code (NEC), local and state requirements.
 - 2. Cable must be separated from any open conductors of Power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, as per NEC Article 760-29.
 - 3. Wiring for 24 volt control <u>shall</u> be run in the same conduit as initiating and signaling line circuits. All other notification style fire alarm circuits shall be routed in separate conduit. All circuits shall be provided with transient suppression devices and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.
 - 4. Conduit shall not enter the fire alarm control panel, or any other remotely mounted control panel equipment or backboxes, except where conduit entry is specified by the FACP manufacturer.
 - 5. Conduit shall be ³/₄ inch (19.1 mm) minimum and shall be fully color coded RED.
 - 6. Conduit system shall adhere to the Class A requirements of NFPA 72 (2010 Edition). Refer to shop drawing section for additional requirements.

B. Wire:

- 1. All fire alarm system wiring must be new.
- 2. Wiring shall be in accordance with local, state and national codes (e.g., NEC Article 760) and as recommended by the manufacturer of the fire alarm system. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 16 AWG (1.02 mm) for initiating device circuits, signaling line circuits and audio notification circuits, and 14 AWG (1.63 mm) for notification appliance circuits.
- 3. All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signaling system.
- 4. Wire and cable not installed in conduit shall have a fire resistance rating suitable for the installation as indicated in NFPA 70 (e.g., FPLR), 2011 Edition.
- 5. Wiring shall be installed in accordance with NFPA72, 2007 Edition requirements regarding survivability, in either 2-hour rated shafts, use of 2-hour rated cable assemblies or similar acceptable alternatives. Refer to riser diagrams for specific locations where 2-hour protection is required.
- 6. All field wiring shall be completely supervised. In the event of a primary power failure, disconnected standby battery, removal of any internal modules, or any open circuits in the field wiring; a trouble signal will be activated until the system and its associated field wiring are restored to normal condition.
- 7. All voice speaker circuits shall use twisted/shielded pair to eliminate cross talk.
- C. Terminal Boxes, Junction Boxes and Cabinets: All boxes and cabinets shall be UL listed for their intended purpose.
- D. Initiating circuits shall be arranged to serve like categories (manual, smoke, waterflow). Mixed category circuitry shall not be permitted except on signaling line circuits connected to intelligent reporting devices.
- D. The fire alarm control panel shall be connected to a separate dedicated branch circuit, maximum 20 amperes. Provide breaker "lock-on" kits for all new and existing branch circuits utilized for fire alarm equipment. This circuit shall be labeled at the main power distribution panel as FIRE ALARM. Fire alarm control panel primary power wiring shall be 12 AWG.

3.4 FIELD QUALITY CONTROL

- A. Quality Control: The system shall be installed and fully tested under the supervision of trained manufacturer's representative. The system shall be demonstrated to perform all the functions as specified.
- **3.5** ACCEPTABLE INSTALLERS
 - A. Trained Personnel: The Fire Alarm System specified herein shall be installed by a factory trained and authorized installer.
 - B. Installation: Field Connected Devices may be installed and wired, and primary power may be wired by licensed contractors under the direct supervision of a factory trained and authorized distributor.

3.6 EXAMINATION

- A. Examination: Prior to the commencement of any of the work detailed herein, an examination and analysis of the area(s) where the Fire Alarm System and all associated components are to be installed shall be made.
- B. Notification: Any of these area(s) that are found to be outside the manufacturers' recommended environments for the particular specified products shall be noted on a Site Examination Report which shall be given to the Engineer of Record.
- C. Shorts: Any shorts, opens, or grounds found on existing wiring shall be corrected prior to the connection of these wires to any panel component or field device.

3.7 INSTALLATION OF CEILING DETECTORS

- A. General: All ceiling mounted detectors shall be installed in accordance with requirements of NFPA 72, 2010 Edition. Detectors shall be positioned to avoid drafts from supply air diffusers and an adequate distance from equipment producing sudden temperature changes which would result in nuisance false alarms. Ceiling smoke detectors shall be so located as to not allow supply air grills to impede the effective operation of the detector. Position detector a minimum of 3 feet from supply air grills.
- B. Mounting: Utilize a manufactured tile bridge to properly support the detector backbox from the ceiling grid system. Provide each detector backbox with properly sized mud-ring for a complete installation.

- C. Protection: Provide temporary protection for all detectors installed prior to completion of construction.
- 3.8 INSTALLATION OF DUCT DETECTORS
 - A. General: Installation of duct mounted smoke detector housings and sampling tubes within the supply and return air ductwork shall be installed per manufacturer's instructions. Locate remote test stations for all concealed location duct detectors as follows:
 - 1. For concealed locations above accessible ceilings, locate remote test station directly below detector location and on public/corridor side of wall (if applicable). Locate device to maintain access to detector above.
 - 2. For mechanical room locations, locate remote test stations in corridor ceiling directly outside of main entrance to the room in which the device is located.
 - B. Location at AHU equipment: Detector shall be mounted at least 6 duct widths downstream, from any duct opening, deflection plates, sharp bends or branch connections.
 - C. Location at Fire/Smoke Dampers: Detector shall be mounted within 5'-0" of every fire/smoke damper prior to any duct take-off. Refer to Florida Building Code Chapter 7 for allowable exceptions.
 - D. Duct Detector Testing: Provide air pressure differential test data to engineer in areas where distance is limited by physical restraints.
 - E. Assurance: Proper air velocities shall be maintained per the manufacturer's specifications.
 - F. Wiring: It shall be the Contractor's responsibility to provide the proper blackbox and sampling tubes for installation within the ductwork. All electrical connections shall be completed by the Fire Alarm Contractor as required for a complete system.
 - G. Access: Provide access panels in ductwork to afford proper service and maintenance of the duct detector. Refer to division 23 specifications for requirements.
 - H. Detectors shall be installed within all the supply and return air ducts in order to comply with NFPA and the Florida Building Code.
- 3.9 DOORS IN SMOKE WALLS
 - A. Smoke Detectors: Smoke detectors located at doors in smoke walls shall be located no further than 5 feet and no less than 1 foot from the door.
 - B. Non-Smoke Walls: Doors located in non-smoke walls shall not be required to release on fire alarm (NFPA 72, Section 5.14.6.5.1, 2010 Edition). Additionally, smoke detectors shall not be required at these locations.
- 3.10 SPRINKLER SYSTEM
 - A. Tamper Switch Supervisory System: Provide connections for sprinkler system tamper switches as required.
 - B. Waterflow Switch: Provide connections to waterflow switches to the waterflow zone as required.
- **3.11** ELEVATOR RECALL AND DETECTION SYSTEM

- A. Installation: Contractor shall provide all raceway wiring and associated devices and detectors for Phase I recall and emergency elevator power disconnection.
- B. Elevator Shaft Detectors: Provide fixed temperature, 135 degrees F, heat detectors for elevator shaft locations, and elevator control and/or equipment rooms.

3.12 INSPECTIONS AND INSTALLATION TESTING

- A. Local Authority Having Jurisdiction: Equipment shall be installed and located in accordance with requirements of the local authority having jurisdiction.
- B. Demonstration: Each of the intended operations of the installed Fire Alarm / Life Safety System shall be demonstrated to the Building Owners' Representative and the Local Authority Having Jurisdiction.
- C. Personnel: The Contractor shall provide equipment and personnel, as required, for acceptance tests and any tests required by inspecting authorities.
- D. Deficiencies: The Contractor shall correct all system installation deficiencies and make all necessary adjustments at no cost to the Owner. Perform another acceptance test after correction of deficiencies.
- E. Notification: Before proceeding with any testing, inform the staff of the location where the alarm signal will sound to prevent any unnecessary action. At the conclusion of testing, those previously notified (and others necessary) shall be further notified that testing has been concluded.
- F. Hazardous Locations: Any method or device used for sensing in an atmosphere or process classified as hazardous by Article 500 of NFPA 70, 2011 Edition, National Electric Code, shall be listed, and suitable for such use.
- G. Reports: Records of all inspections and tests shall be made and submitted at the conclusion of work.
- H. Provide Inspection and Testing Form from NFPA 72, 2010 Edition to the Engineer and Owner and shall be included in O & M Manual.

3.13 SMOKE DETECTOR SENSITIVITY TESTING

- A. Testing: Sensitivity settings shall be recorded for all heads and submitted to Engineer at completion.
- B. Testing of Existing Equipment: Inspections and tests of existing equipment shall be performed to insure that all control functions, operating panels, annunciation devices and each detector is in reliable operating condition. This equipment shall be connected to the new system so all control functions, annunciation, etc. operate as one system.

3.14 HEAT DETECTOR TESTING

A. Procedure: A restorable heat detector and the restorable element of a combination detector shall be tested by exposing the detector to a heat source, such as a shielded heat lamp, until it responds. After each heat test, the detector shall reset.

B. Precaution: Precaution shall be taken to avoid damage to the non-restorable fixed temperature element of a combination rate-of-rise fixed temperature detector. The manufacturer's instructions shall be followed.

3.15 SMOKE DETECTOR TESTING

- A. Response: To assure that each smoke detector is operative and produces the intended response, it shall be caused to initiate an alarm as its installed location with smoke or other aerosol, acceptable to the manufacturer that demonstrates that smoke can enter the chamber and initiate an alarm.
- B. Method: To assure that each smoke detector is within its listed and marked sensitivity range, it shall be tested using either one of the following:
 - 1. A calibrated test method.
 - 2. The manufacturer's calibrated sensitivity test instrument.
 - 3. Listed control equipment arranged for the purpose.
 - 4. Other calibrated sensitivity test method acceptable to the authority having jurisdiction.
- C. Range: Detectors found to have a sensitivity outside the accepted range shall be replaced.
- D. Exception: Detectors listed as field adjustable may be either adjusted within an accepted range or replaced. <u>Note</u>: The detector sensitivity cannot be tested or measured using any spray device that administers an unmeasured concentration of aerosol into the detector.
- E. FACP shall generate a smoke detector sensitivity report for all connected and installed detectors.

3.16 CLEANING

A. Method: Clean all detectors and remove dust or dirt that has accumulated. For each detector, the cleaning, checking, operating, and sensitivity adjustment shall be attempted only after consulting the manufacturer's instructions. These instructions shall detail methods such as vacuuming to remove loose dust and insects and washing to remove heavy grease and grime deposits. In lieu of these cleaning methods, the manufacturer may provide cleaning service at the field location. Following partial disassembly or washing of the detector to remove contamination, the appropriate sensitivity test required shall be performed.

3.17 SEQUENCE OF OPERATION

- A. Survivability: The sequence of alarm is based on a "by smoke compartment" survivable concept. Each individual smoke compartment is to be considered a distinct, separate evacuation and signaling zone. Each "zone" is comprised of a single smoke compartment, unless specifically noted otherwise. "Survivability" concepts per NFPA 72, 2010 Edition, Section 6.9.4 is applicable to each evacuation "zone".
- B. Manual: Upon activation of the fire alarm system by any manual initiating device, including manual pull stations, the following shall take place:
 - 1. Flash the visual fire alarm signals (strobes) throughout the zone in alarm only.
 - 2. Sound the audible fire alarm signals, via the primary voice evacuation message, throughout the zone in alarm only. The primary voice evacuation message shall be as follows:

- a. Public Areas: (3) Fast Whoops followed by the following message repeated twice: "May I have your attention please (repeated twice), there has been a fire alarm activated in this area. Please proceed to the nearest exit."
- b. Patient Areas: (3) Fast Whoops followed by the primary message repeated twice: "May I have your attention please (repeated twice), there has been a code red alarm activated in this area, please stand by for staff instructions."
- c. Whoops and message for the primary voice messages are repeated until system reset or silence.
- 3. Sound the audible building wide voice message, throughout all remaining areas in the building on all levels. The building wide voice message shall be as follows:
 - a. Continuous Alert Tone for 6 seconds followed by the general page message repeated three times: "Code Red, Floor Level". (For example, a 3rd floor alarm would sound "Code Red, 3rd Floor").
 - b. Whoops and message for the building wide voice message are not repeated.
 - c. Building wide messages for the project area currently do not exist will require that new messaging be recorded for the sequence of operation.
- 4. Close all magnetically held open doors within the zone in alarm and all other zones located within the same floor.
- 5. Release all electrically locked doors and close any fire control doors (Won-Door at smoke compartment between Servery and Dining Area and overhead coiling door between smoke compartments at the kitchen and the tray drop-off alcove) on the floor of the alarm condition. Manual pull stations associated with these units shall not release magnetic door locks upon activation of the fire alarm system.
- 6. Manual activation shall not initiate any smoke control or HVAC shutdown sequence of events.
- C. Automatic: Upon activation of the fire alarm system by any smoke detector or heat detector (including those associated with Elevator Phase 1 Recall systems), or sprinkler flow alarm, the following shall take place in addition to the manual sequence above:
 - 1. Shut down all air handlers and exhaust fans supplying or exhausting air in the zone in alarm, plus remaining zones located on the same floor of the building. Adjacent zones located on levels/floors above and below, or in adjacent wings, shall not shutdown unless specifically required due to shared or location of HVAC systems.
 - 2. Activation of supply and return duct mounted smoke detectors shall shut-down the associated air handling unit and interlocked exhaust systems and shall provide a supervisory alarm to the fire alarm system only. Duct mounted smoke detectors shall not place the building into full alarm status.
 - 3. Shutdown all fan coil units serving exit access corridors.
- C. Elevator Lobby Detection: Activation of any elevator lobby (except the first floor lobby), hoistway or machine room smoke detector shall initiate the elevator Phase I recall system to the affected elevator and initiate an alarm for the zone it is located within. Activation of the lobby smoke detector on the first floor shall send a separate signal to the elevator controller to send the car to the alternate fire department access level.

- D. Elevator Machine/Shaft Way Detection: The elevator top of shaft smoke detector shall energize the flashing warning light at the designated and alternate fire department access levels.
- E. Elevator Control Room Detection: The elevator control room smoke detector shall energize the flashing warning light at the designated and alternate fire department access levels.
- F. Elevator Shunt Trip: Activation of any elevator hoistway heat detector or the control room heat detector shall initiate shunt trip of the affected elevator power supply, and by use of an auxiliary contact, initiate an alarm for the zone it is located within. Provide all necessary interfaces and materials to connect to the shunt trip circuit of the elevator circuit breaker, and power the mechanism. Utilize shunt trip power from the breaker controlled. Provide wiring system to the elevator controller for final connection by the elevator contractor.
- G. Elevator Alarm: Elevator lobby detectors shall be cross zoned, by means of software, to indicate an alarm in the zone covering the corridor where located and indicate that the vertical elevator zone is in alarm as well.
- H. Supervisory: System supervisory faults, such as shorts, opens, and grounds in conductors, operating power failure, or faults within supervised devices, shall cause an audible and visual trouble indication at the control panel. It shall be possible to silence the audible trouble signal. Once the trouble is corrected, the signal shall again sound until the silence switch is restored to its normal position.
- I. Sprinkler Flow Switch: The fire protection sprinkler system main flow switch shall be connected as an alarm initiating device and shall be annunciated as a separate zone. Fire protection sprinkler system zone flow switches shall be connected as an automatic initiating device and each switch shall be separately annunciated and zoned.
- J. Sprinkler System Tamper Switch: Tamper switches connected to valves of the fire protection sprinkler system shall be annunciated as an audible and visual trouble system.
- K. System Bypass Features: Any system bypass feature currently existing or created as part of this project (such as AHU bypass, WON door bypass, etc) shall initiate a system trouble condition with description of bypass function be activated (i.e. Trouble WON Door Bypass activated) when the bypass feature is activated. Upon reset of the fire alarm system, all bypass functions shall be reset to normal operating conditions.

3.18 SYSTEM STARTUP, OWNERS' INSTRUCTIONS, COMMISSIONING

- A. Startup: System startup shall be performed by Factory Trained personnel. Certain functions of the Systems Startup Procedure may be performed by a contractor under the direction of the Factory Trained and Authorized Engineered Systems Distributor.
- B. Instructions: Owners' Instructions and Operation Manuals, specific for this project, shall be supplied to the Building Operations Staff by the Factory Trained and Authorized Engineered Systems Distributor. A "Generic" or "Typical" Owners' Instruction and Operation Manual shall not be acceptable to fulfill this requirement.
- C. Commissioning: Commissioning of the installed system shall be performed by the Factory Trained and Authorized Engineered Systems Distributor in the presence of the Local AHJ, the Building Owners' Representative, and a Representative of the General Contractor.

3.19 MAINTENANCE

- A. First Year Tests: The Contractor shall, at no expense to the Owner, observe the systems in operation and conduct tests to assure that systems are performing in full compliance with specified requirements at least twice during the initial 6 months of operation. The testing shall be coordinated with a designated Owners representative, at a time convenient to the Owner, with results reported in writing to the Owner.
- B. Maintenance Contract: The factory trained and authorized distributor who designed and installed this system shall make available to the Owner a separate maintenance contract for a period of two (2) Years from the date of system commissioning. Maintenance quotation shall include all NFPA 72, 2010 Edition requirements. The cost for this maintenance contract shall not be included in the base bid.

END OF DOCUMENT 28 3111

SECTION 28 3115 FIRE ALARM SYSTEM GRAPHIC WORKSTATION

PART1- GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 SECTION INCLUDES

A. This specification includes the furnishing, installation, connection, and testing of a PC based graphical facilities monitoring system for graphical annunciation of the building floor plan and fire alarm activations for the project scope; including Underwriters Laboratories (UL) listed application software and hardware complete and ready for operation.

1.3 REFERENCES

- A. The equipment and installation shall comply with the provisions of the following standards:
 - 1. NFPA 70 National Electric Code, 2014 Edition
 - 2. National Fire Protection Association Standards:
 - a. NFPA 72 National Fire Alarm Code, 2013 Edition
 - b. NFPA 99 Health Care Facilities, 2015 Edition
 - c. NFPA 101 Life Safety Code, 2015 Edition
 - 3. Local and State Building Codes:
 - a. Florida Fire Prevention Code
 - b. Florida Building Code
 - c. State Elevator Code
 - 4. Local Authorities Having Jurisdiction.
 - 5. Underwriters Laboratories Inc.
 - 6. The system and all components shall be listed by Underwriters Laboratories Inc. for use in fire protective signaling system.
 - 7. Americans with Disabilities Act (ADA) and State Equivalents.

1.4 PROJECT DESCRIPTION

- A. This section of the specification includes the furnishing, installation, and connection of a PC based graphical facilities monitoring system shall be installed in accordance to the project specifications and drawings. Graphics package shall be generated for the entire fire alarm system network, including both the hospital and medical office building.
- B. The PC based graphical facilities monitoring system shall include, but not be limited to, one (1) PC based graphical workstation, all input/output devices, network communications media, control equipment, auxiliary control devices, power supplies, and wire / fiber optic media as shown on the drawings and specified herein.

- C. A supervised interface to NOTIFIER fire alarm control panels and NOTI-FIRE-NET shall be provided.
- D. The system shall employ an advanced technology network to monitor and control various fire alarm information over a LonWorks network.
- E. The system shall include an interface to digital alarm communicator receivers for wide area network monitoring.
- F. The system shall allow a mixture of different technologies and manufacturers' equipment to operate on the same network and provide the operator with a consistent look and operation for all monitored equipment.
- G. The system shall support a variety of topologies and media and shall provide an industry standard open architecture transport layer protocol.
- H. Using standard RS 232 ports on existing and future monitoring and control systems used by the facility, the system shall connect to and interpret status change data transmitted from the ports and provide graphic annunciation, control, history logging and reporting as specified herein.
- J. The system shall be electrically supervised and monitor the integrity of all conductors.

1.5 SUBMITTALS

- A. Shop Drawings: Shop drawings shall be complete showing all wiring diagrams and point to point connections required for this project. The point to point connections shall be indicated on drawings showing routing of raceways, connections, components, and conductor quantities and types. The Contractor shall apply his company name, address, telephone number, etc. Computer CAD drawings are required.
- B. Software Modifications
 - 1. Provide the services of a factory trained and authorized technician to perform all system software modifications, upgrades or changes. Response time of the technician to the site shall not exceed 4 hours.
 - 2. Provide all hardware, software, programming tools and documentation necessary to modify the fire alarm system on site. Modification includes addition and deletion of devices, circuits, zones and changes to system operation and custom label changes for devices or zones. The system structure and software shall place no limit on the type or extent of software modifications on-site. Modification of software shall not require power-down of the system or loss of system fire protection while modifications are being made.
- C. Product Data: Submit manufacturer's standard catalog data on all components and sub-systems. Product data shall be submitted showing manufacturer's written recommendations for storage and protection, and installation instructions. Manufacturer's product data shall be submitted for all system equipment including;
 - 1. Application Information
 - 2. Dimensions
 - 3. Listing Agency File
 - 4. Wiring Diagrams
 - 5. Installation Information

- D. Annual Inspections: The Contractor shall provide hourly Service Rates and Semi-Annual inspection prices, performed by a factory trained and authorized personnel, for this installation with the submittal. Proof of training and authorization of the servicing personnel shall be included in the submittal. The hourly service rates shall be guaranteed for a one-year period unless otherwise specified.
- E. Close-out Submittals: Electronic copy of the following information shall be delivered to the Building Owner's representative at the time of system acceptance. The close out submittals shall include:
 - 1. Operating manuals covering the installed Fire Alarm System.
 - 2. Point to Point diagrams of the entire workstation system as installed. This shall include all connected devices and field modules. All drawings shall be provided in CAD and supplied in standard .dwg format. Bond plots of each sheet shall also be provided. A system-generated point to point diagram is required to ensure accuracy.
 - 3. The application program listing for the system as installed at the time of acceptance by the building owner and/or Local AHJ (Disk and Hard copy printout).
 - 4. Name, address and telephone of the authorized factory representative.
 - 5. All drawings must reflect device address and programmed characteristics as verified in the presence of the engineer and/or the end user unless device addressing is electronically generated, and graphically printed.
 - 6. Certificate of Training.

1.6 QUALITY ASSURANCE

- A. Qualifications: Provide proof of qualifications as Factory Authorized and Factory Trained for the product(s) specified herein. These qualification credentials shall not be more than two years old, to ensure up-to-date product and application knowledge on the part of the installing firm. Only a factory-trained and certified technician shall program the system. Provide proof of certification of programmer within submittal.
- B. Warranty Period: The Contractor shall provide warranty service at no additional cost to the Owner for a period of 12 months from the date of substantial completion of the installation.
- C. A copy of the manufacturers' warranty shall be provided with closeout documentation and included with the operation and installation manuals.

1.7 WORKSTATION PERFORMANCE

- A. The network will interface and report the individually monitored system's status via a user-friendly Graphical User Interface (GUI) based software workstation.
- B. The software shall operate under Microsoft® Windows® XP Professional as manufactured by Microsoft Corporation.
- C. The GUI based software must be capable of graphically representing each facility being monitored with floor plans and icons depicting the actual locations of the various systems and/or device's locations.
- D. The software shall use a 1024 X 768 GUI display capable of showing a large primary floor plan display, a key map representative of a larger view of the primary display and its relationship to

the facility being monitored, the current operator, number of fire, supervisory, pre-alarms, troubles, and security events within the network as well as outstanding events and acknowledged events.

- E. The workstation shall have the ability to support graphic printing of all data including graphical floor plans, system activity, history, and guidance text. A Windows compatible printer shall be supported for the graphics and report printer options.
- F. The workstation software shall permit automatic navigation to the screen containing an icon that represents the system or device in the event of an off-normal condition.
- G. The system/sensor icon shall indicate the type of off-normal condition and shall flash and change to the color associated with the off-normal condition (e.g., RED for ALARM and YELLOW for TROUBLE).
- H. The software shall allow the attachment of text (TXT) files, sound (WAV) files, image (BMP) files and video (AVI) files to each system or sensor icon allowing additional information to be provided to the system operator for responding to the off-normal condition.
- I. The software shall allow the importation of externally developed floor plans in Windows Metafile (WMF), JPEG (JPG), Graphics Interchange Format (GIF) and Bitmap (BMP) format.
- J. The software shall provide auto-navigation to the screen containing the icon of any system or device when an event is initially annunciated. In addition, operator navigation to screens containing outstanding events shall be accomplished by "clicking on" the event from either the acknowledged or unacknowledged event.
- K. History Manager. The software shall contain a History Manager, which shall record all system events with a time and date stamp as well as the current system operator's name.
 - 1. The system shall provide for the ability to store all off-normal events experienced by the various sub-systems that are monitored by the system.
 - 2. All events shall be recorded with a time and date stamp and the system operator shall be provided with the ability to log a pre-defined response or a custom comment for each offnormal event and have that comment stored in the history file with the time, date and operator name.
 - 3. Provide for the ability to conduct searches and generate subsequent reports, based on all events for a single system / device address, a specific node, a specific type of off-normal condition and date range (mm/dd/yy to mm/dd/yy) or combinations of these search parameters. The number of entries in the history file that match the determined search criteria will be displayed.
 - 4. The History Manager shall signal a need to back-up the history file at 100,000 events and then remind the operator at intervals of 100 events thereafter.
 - 5. It shall be possible to pre-select data fields for reporting and then saving the report as a template with a file name. It shall also be possible to schedule the pre-defined report to print at a designated time.
- L. Alarm Monitoring. The system shall provide for continuous monitoring of all off-normal conditions regardless of the current activity displayed on the screen.

- 1. If an operator is viewing the history of a sub-system and an alarm condition should occur, the system shall automatically navigate to the graphic screen showing the area where the off-normal event is occurring.
- 2. The system shall prioritize all off-normal events as defined by Underwriter's Laboratories into the following categories: fire alarms, troubles, supervisory alarms, pre-alarms and security alarms.
- 3. The system shall display a running count of all events by type in an alarm event counter window. The event counter window shall include five counters, defaulted to Alarm, Trouble, Security, and Supervisory events.
- 4. The system shall show a running list of all unacknowledged events and acknowledged events and allow the system operator to acknowledge an event by "double-clicking" on that event in the Unacknowledged Events box. The Unacknowledged and Acknowledged Events boxes shall contain an abbreviated description of the off-normal condition.
- 5. The details of the condition may be viewed by selecting event in the unacknowledged events box.
- 6. The system shall allow the attachment of user-definable text files, image files and sound files, to each device / system monitored in order to facilitate the operators and response personnel's response to the off-normal condition.
- 7. The system shall record all events to the system's hard drive. A minimum of 100,000 events may be stored.
- M. Reports & Logs:
 - 1. The system shall provide for the ability to generate reports based on system history.
 - 2. The system shall allow the system operator to enter custom comments up to 255 characters for each event and have those comments recorded in the system's history file.
- N. Boolean Logic:
 - 1. An automated event response application shall be provided to automatically perform actions across the entire system based on network activity.
 - 2. The event response application shall allow event responses (actions) based on predefined user conditions using simplified Boolean logic.
 - 3. Actions shall be configured to be executed immediately or timed as required.
- O. Control Aspects of System Software:
 - For future functionality, the system shall provide for the direct control of all outputs associated with Input / Output dry contact relay points on Network Input/Output Nodes (NIONs). In addition, the system shall have the ability to control and program a sub-system Notifier AFP-1010, AM-2020, or AFP-400 Fire Alarm Panel through a terminal mode window (ASCII terminal type connection) interface to microprocessor-based sub-systems via an RS 232 serial NION if available as an ancillary feature.
 - 2. The system shall have the ability to monitor and control NOTIFIER® Fire Alarm Panels: AFP-1010, AM2020, AFP-200, AFP-300/400, and ONYX® series control panels.

- 3. Discrete I/O NION interfaces allow the system operator to initiate a change of state for the associated dry contacts.
- 4. A scheduling utility shall be included with the workstation to configure the I/O points on these NIONs for automated activate/deactivate, and Arm/Disarm (depending on device type) status.
- 5. The workstation shall provide configuration utilities for monitoring and control profiles. These profiles shall be user definable for distribution of monitoring and control allowances for operators per workstation.
- 6. Terminal mode interfaces using serial NIONs (if available for the specific system) shall be available to allow full programming and control of the system being monitored and shall provide the operator with the ability to take advantage of all features supported by a CRT attached to the associated individual sub-system.
- 7. Under no condition shall any sub-system be required to rely on the network for any data processing required to perform its particular function. Each individual sub-system shall be in effect "stand-alone" as to insure it's continued operation should a disruption in communication with the system be experienced.
- P. The software shall be password protected and provide for the definition of security profiles for operator access control.
- Q. The software shall contain provision for defining monitoring profiles of pre-selected NIONs for monitoring. This shall include provision for status types within the selected NODES.
- R. The software shall contain provision for defining control profiles of pre-selected NIONs for control.
 - 1. The system administrator shall be provided means to select which signals can be controlled by selected Workstation.
- S. The software shall support live voice paging for mass notification to NOTIFIER voice evacuation system over Internet Protocol (IP).

PART 2 - PRODUCTS

- 2.1 GENERAL
 - A. Basis of Design: The basis of design shall be manufactured by as provided by NOTIFIER®. Model numbers specified are those of NOTIFIER® and are to establish the minimum standard of operating characteristics and quality.
 - B. All equipment and components shall be new, and the manufacturer's current model. The materials, equipment and devices shall be tested and listed by a nationally recognized approval agency.
- 2.2 WORKSTATION
 - A. The system shall be an ONYXWorks[™] Facilities Monitoring System.
 - B. The system shall operate on an IBM compatible UL listed Intel processor operating at no less than 3.0 GHz on the Microsoft® Windows® Professional platform.

- C. The workstation shall have: no less than 8 gigabytes of RAM, a hard drive with no less than 500 Gigabytes of storage space, a minimum of 256 megabytes of video RAM, a CD-R/W for system backup, internal supervisory CPU watchdog board with audible annunciator, 100 Base-T Ethernet NIC card, a 104 key keyboard, and a mouse type pointing device.
- D. The workstation shall come equipped with all necessary gateway modules to allow connection to the network it monitors as standard equipment. All workstations shall support Ethernet communications when multiple workstations are required.
- E. The workstation shall support an SVGA monitor and be supplied with a 21" flat screen LCD monitor.
- F. Workstation must be connected to a supervised Uninterruptible Power Supply (UPS) that is regulated, UL 1481 listed, and power limited.
- G. The computer shall be capable of networking to additional computers and these computers shall be capable of operating as workstations and/or gateways for local area or wide area networks.
- H. Alarm annunciation shall appear on all workstations and may be silenced at each local workstation. The system shall permit only one workstation and operator to be in command of the system for global alarm acknowledgement at any time.

2.3 INTEGRATION NETWORK

- A. The integration network shall be capable of monitoring a minimum of 100 nodes (NIONs and routers) on an integration gateway consisting of, but not limited to:
 - 1. Intelligent or conventional fire alarm control panels.
 - 2. Competitor's intelligent or conventional fire alarm control panels.
- B. Up to 99 gateways shall be connected via Ethernet for a total local area combination of up to 12672 (99x128) nodes.
- C. Local area networks shall consist of a free topology network using twisted pair copper media in a bus, star, T-tap, or ring style 7 configurations at 78 Kilo baud. Transmit/receive twin fiber (multi-mode 62.5/125 μm) strand FT-10 point-to-point topology and bidirectional FO-10 networks shall also be available. Wide area networks shall be supported by the use of network expansion routers.
 - 1. Free topology (FT-10 style) wire network run allows multiple T-taps within a 1,500-foot (457.2 m) radius; 8,000 foot (2438.4 m) point-to-point using twisted pair; or 6,000-foot (1828.8 m) bus topology.
 - 2. Free topology (FT-10 style) fiber network can also use fiber-optic cabling. Operates at 78.5 Kbaud.
 - 3. Fiber optic (FO-10 style) network allows bus or ring topology using only fiber-optic cabling; node-to-node distance of over 10,000 feet (3048 m) with message regeneration. FO-10 style operates at 1250 Kbaud and utilizes multi-mode bi-directional fiber media (single fiber strand) in a bus or loop configuration.
- D. Provide routers, repeaters or bridges where required to increase distance, alter network configuration or change media or to extend to remote facilities over alternate communications media including UL listed dial-up PSTN telephone, leased line, multimode fiber or Ethernet connectivity.

- 1. Dial-up units shall dial a local number and stay connected. Upon loss of carrier, a supervisory alarm shall be indicated at the workstation and the units shall automatically redial to connect.
- 2. Network expansion routers shall support public switched telephone circuits, two-wire or four-wire leased lines, and CAT5 Ethernet networks.
- E. Network interface software shall be by the same manufacturer as the hardware portion of this specification.
- F. The integration network shall utilize Network Input / Output Nodes (NIONs) to interface between the individual buildings' systems to be monitored by the integration network. The NIONs shall act as a translator from the building system's specific panel communications protocol to the integration network protocol as well as serve as a transceiver from the building system panel to the integration network.
 - NIONs shall be available in configurations that will allow transparent communications via RS 232 serial data ports with intelligent fire alarm control panels, security systems, and CCTV systems.
 - 2. NIONs shall be available in configurations that will allow monitoring of dry contacts, switched voltages, conventional security devices, access control panels and conventional fire alarm control panels using scheduled, automated and manual control.
 - 3. NIONs shall be UL listed to Standard 864 and 1076 and be provided with their own enclosure or be available in chassis mount configurations.
 - 4. NIONs shall operate at 24 VDC and obtain their power from the monitored control panel or a UL listed battery backed auxiliary power supply. All terminals shall be transient protected to 2400V and LEDs shall be provided for status, service and diagnostics.
- G. Digital Alarm Communicator Receiver Network
 - 1. The system shall provide a digital alarm communicator receiver (DACR) gateway with a RS 232 interface to the following digital alarm communicator receivers for wide area event reporting: Ademco 685, Silent Knight 9500 and 9800, Radionics 6600.
 - 2. Each gateway shall support up to 10 digital alarm communicator receivers for alarm and trouble information from reporting devices.
- H. Workstation Network:
 - 1. Computers shall be networked using Ethernet supporting the use of TCP/IP protocol for local area systems.
 - 2. The network shall be capable of supporting multiple clients (e.g., workstations, configuration applications, automated response applications) and up to ninety-nine (99) gateways.
 - 3. A UL listed Ethernet Hub shall be provided for connection of multiple workstations, gateways, clients, and/or network printers.
 - 4. System shall be UL listed to communicate between clients and gateways over a business computer network (shared IP).

5. System shall be capable of exposing all data over BACnet/IP. Verification of operation shall be confirmed by FH Control Systems Division and a chosen 3rd party integrator (JCI, Siemens or Trane TBD).

PART 3 - EXECUTION

- 3.1 GENERAL
 - A. All equipment and components shall be installed in strict compliance with manufacturers' recommendations. Consult the manufacturer's installation manuals for all wiring & fiber optic diagrams, schematics, physical equipment sizes, etc., before beginning system installation. Refer to the riser/connection diagram for all specific system installation / termination / wiring data.

3.2 CONDUIT AND WIRE

- A. Conduit shall be in accordance with the National Electrical Code (NEC), local and state requirements.
- B. Where possible, all wiring & fiber optics shall be installed in conduit or raceway.
- C. Cable must be separated from any open conductors of power, or class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, as per NEC Article 760-29.
- D. All circuits shall be provided with transient suppression devices and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.
- E. Conduit shall not enter the control equipment, or any other remotely mounted control panel equipment or back-boxes, except where conduit entry is specified by the FACP manufacturer.
- F. All system wiring shall be new except as allowed herein and approved by the manufacturer for intended communications using NOTI-FIRE-NET or Echelon's LonWorks.
- G. Wiring & fiber optics shall be in accordance with local, state and national codes (e.g., NEC Article 760) and as recommended by the manufacturer of the fire alarm system. Number and size of conductors & fiber optics shall be as recommended by the fire alarm system manufacturer.
- H. All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signaling system except as specified herein.
- I. All communication wire to nodes or to computers shall consist of minimum manufacturer's recommendations and approved wire specification supporting speeds of 78Kps to 10mB/sec communications.

3.3 TERMINAL BOXES, JUNCTION BOXES, AND CABINETS

- A. All boxes and cabinets shall be UL listed for their use and purpose.
- B. The PC based workstations shall be connected to a separate dedicated branch circuit, maximum 20 amperes. This circuit shall be labeled at the main power distribution panel as FACILITIES FIRE ALARM MONITORING SYSTEM. A UL 864 listed UPS system shall be provided.
- 3.4 SYSTEM SETUP & CONFIGURATION

- A. Building Floor Plans: Architectural floor plans of the entire project scope area will be provided to the contractor in Autocad 2010 Format for use in development of the Graphics Package. All graphics plans shall be submitted for review and approval prior to implementation into system.
- B. Building Fire Alarm Plans: Contractor shall be responsible for the as-builting of all fire alarm devices to develop a total device list, address and location plans for incorporation into the graphics package. All graphics plans shall be submitted for review and approval prior to implementation into system.
- C. All graphics for each construction area shall be created and installed on the network prior completion of the fire alarm upgrades for that area. Creation of graphics after the work is completed is not permitted.
- D. Provide the services of a factory trained and authorized technician to perform all system software modifications, upgrades or changes. Field technicians shall be NICET Level 1 (minimum) certified.
- E. The factory trained technician shall install initial data and artwork at each workstation including:
 - 1. Distribution of monitoring, control and security profiles as requested by owner.
 - 2. Area diagrams, floor plans, key maps and screen titles.
 - 3. Auto-navigation criteria.
 - 4. Guidance text as provided by owner.
- 3.5 FINAL INSPECTION
 - A. At the final inspection a factory trained representative of the manufacturer of the major equipment shall demonstrate that the system function properly in every respect.
- 3.6 INSTRUCTION/TRAINING
 - A. Provide instruction as required for operating the system. Hands on demonstrations of the operation of all system components and the entire system including user-level program changes and functions shall be provided. A factory trained and certified representative shall provide instruction.

END OF SECTION 28 3115

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

- A. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 1 Sections, apply to this section.
- B. Examine all drawings and all other sections of the specifications for requirements therein affecting the work of this section.
- C. Coordinate Work with that of all other trades affecting or affected by the work of this section. Cooperate with such trades to assure the steady progress of all Work under the contract.

1.2 SUMMARY

- A. Section includes all work required to construct the facilities shown on the Drawings.
- B. Earthwork includes, but is not limited to:
 - 1. Topsoil stripping.
 - 2. Proof rolling.
 - 3. Rough grading and shaping.

1.3 RELATED SECTIONS

A. Site Preparation - Section 311001

1.4 QUALITY ASSURANCE

- A. Requirements of Regulatory Agencies: Perform excavation work in compliance with applicable requirements of governing authorities and codes having jurisdiction.
- B. Reference Specifications and Standards:
 - 1. ASTM: D2922 (Nuclear method), or ASTM D1556 (sand-cone method).
 - 2. ASTM: D3017 (Nuclear method), or ASTM D1557 Moisture-Density Relations of Soils, using 10-lb. Rammer and 18-inch Drop.
 - 3. ASTM: D2937, "Density of Soil in Place by the Drive-Cylinder Method."

PART 2 - PRODUCTS

2.1 SOIL MATERIALS - GENERAL

- A. On-site materials: Materials obtained by selective stockpiling of excavated soils. Stockpile only materials acceptable to Soils Engineer.
 - 1. Free of all vegetation, roots, and organic matter, root mat, muck and construction debris as shown on plans.
- B. Borrow materials: Approved materials obtained from a borrow site approved by the Owner.

JFL – THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 F

Harris Civil Engineers

Project No. 07287000 EARTHWORK Section 31 00 00 - 1

- 1. Use only non-expansive clean earth and granular materials, free of vegetation, roots and organic matter, muck, root mat and debris.
- 2. All material brought on-site must be approved by the Owner.

2.2 SOIL MATERIALS FOR SITE GRADING

- A. Use approved on-site or borrow materials.
- B. All soils at or within 12 inches of the surface in areas which are to be landscaped or sodded shall conform to the following:
 - 1. All soil materials shall be subject to approval by the Engineer.
 - 2. Satisfactory soil materials are defined as those complying with the American Association of State Highway and Transportation Officials (AASHTO) M145, soil classification groups A-1, A-2-4, A-2-5 and A-3.
 - 3. Unsatisfactory soil materials are those defined in AASHTO M145 soil classifications groups A-2-6, A-2-7, A-4, A-5, A-6 and A-7; also, peat and other highly organic soils.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions under which earthwork is to be performed and notify the Owner, in writing, of conditions detrimental to the proper and timely completion of work

3.2 PREPARATION

- A. Layout Work and Reference Points:
 - 1. Before starting layout work, check through and verify all principal governing dimensions and make a general check of elevations and grades called for on the Drawings.
 - 2. Locate benchmarks, monuments and other reference points for elevation and location of new work. Notify the Owner of any apparent discrepancies in indicated locations.
 - 3. Protect reference points from dislocation or damage. Contractor shall notify the Owner's project manager immediately in the event of damage to any reference point. Contractor shall repair or replace the reference point at the expense of the Contractor.
 - 4. Accurately locate new work on site according to Contract Documents.
 - 5. Erect batter boards and set grade stakes securely to remain in place until corners and heights are permanently established.
 - 6. Denote areas allocated for storage of various materials. Select storage and working areas to avoid interference with subsequent operations.
 - 7. Do not proceed with construction work until reference points and layout work have been verified.

3.3 EXCAVATION

JFL – THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

- A. Excavation consists of removal and disposal of material of every nature encountered when establishing required grade elevations.
- B. Earth excavation includes removal and disposal of pavements and other obstructions visible on ground surface, underground structures and utilities indicated to be demolished and removed.
- C. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of Owner. Unauthorized excavation, as well as remedial work directed by the Owner, and as recommended by Soils Engineer, shall be at the Contractor's expense.
- D. Additional excavation:
 - 1. When excavation has reached required subgrade elevations, notify the <u>Design Engineer</u>, who will make an inspection of conditions. Do not excavate below indicated depths.
 - 2. If inspection indicates unsuitable material and conditions, additional excavation and corrective work will be paid for by means consistent with terms of Contract conditions.

3.4 DEWATERING

- A. All work areas occurring below the groundwater level shall be drained, dewatered and maintained in stated condition while work is taking place at those elevations.
- B. Dewatering methods shall be those selected by the Contractor, subject to approval by the Owner.
- C. Be responsible for maintaining dry excavations and subgrades continuously while work in each area is being done. Water level shall be reduced to sufficient depth to assure that bottom soils are not saturated or develop a quick condition.
- D. Contractor is responsible for obtaining any dewatering permits that may be required.
- E. Take all measures necessary to prevent subsidence of adjacent property, including but not limited to, groundwater recharge swales.

3.5 FILL, BACKFILL AND COMPACTION

- A. Backfill consists of bedding, backfill and restoration of the surface.
- B. Compaction:
 - 1. Proof roll existing ground and bring each 12 inch lift to optimum moisture content before compaction. Add water by uniform sprinkling.
 - 2. When moisture content and condition of each layer is satisfactory, compact to not less than 95 percent of maximum density, or as elsewhere specified.
 - a. Compact areas not accessible to motor-driven equipment with mechanical or heavy hand tampers.

- 3. Rework compacted areas failing to meet specified maximum density as determined by tests. Re-compact and re-test as required to achieve 95 percent maximum density.
- 4. Correct unauthorized excavation made below depth indicated, as acceptable to Soils Engineer, at no additional cost to Owner.
- 5. Landscape areas: Compaction below all landscape, planting or sod areas shall be 90 percent of maximum density for the full depth of fill.
- 6. Minor structures: Catch basins, and other minor structures shall be supported on bottom and all sides by soils compacted to 95 percent of maximum density.

3.6 GRADING

- A. General:
 - 1. Uniformly grade areas within limits of grading and adjacent transition areas as work included in this Section. Smooth finished surface within specified tolerances. Compact with uniform levels or slopes between points where elevations are shown or between such points and existing grades.
 - 2. Allowable tolerances for grades:
 - a. All cuts and fills shall be graded to necessary subgrade elevations within a tolerance of 0 below to 0.10 feet above grades indicated on Drawings.
 - b. Structures at or on grade shall be within 0.02 feet.
 - c. All elevations and contours shown on the Drawings are to finish grade unless otherwise indicated, and allowance shall be made for pavement thickness and sodding.
- B. Grade areas adjacent to pavement lines to drain away from pavement and to prevent ponding. Finish surfaces free from irregular surface changes.
- C. Grading Surface of Fill Under Pavement: Grade smooth and even, free of voids, compacted as specified and to required elevation.

3.7 FIELD QUALITY CONTROL

- A. General
 - 1. All frequency of testing requirements shall be per the geotechnical engineer.
- B. Test methods:
 - 1. Maximum density of backfill materials will be determined by ASTM D3017 (Nuclear method), or ASTM D1557 Method A (5-layer method) or ASTM D2937.
 - 2. Field density tests will be determined by ASTM D2922 (Nuclear method), or ASTM D1556 (sand-cone method), unless other applicable method is approved.
- C. Required tests:
 - 1. Backfill material: Determine suitability of backfill material not previously evaluated.

JFL – THS 5 ACRE LAND LEASE SITE	
Procurement Package	
07/21/2023	Ha

- 2. Maximum density tests: Determine optimum moisture content and maximum density of backfill materials placed and compacted.
- 3. Compaction inspection: Determine degree of backfill compaction.
- 4. Bedding conditions: Determine and evaluate condition of bedding to receive utility lines.
- D. Inspections and controls:
 - 1. General inspection of stripping of surfaces and removal of root mat, peat, clay and other unsuitable materials or conditions.
 - 2. Detailed inspection of exposed subgrades prior to finishing or placing compacted fills.
 - 3. Continuous control of placing and compacting all compacted fills.
 - 4. Observation and consultation in processes of embankment shaping, safety in excavations, dewatering and identification of materials encountered.

3.8 DAMAGED WORK AND REPAIRS

- A. Repairs: Sections of curbing, concrete and asphalt paving and other permanent features which have been damaged during and as a result of construction operations in connection with this Contract shall be removed and the full section between joints shall be replaced at no additional cost to Owner.
- B. Replacement of grass, shrubs or trees: All grass areas, shrubs or trees which have been rutted or damaged or broken during and as a result of construction operations in connection with this Contract shall be removed and replaced. This shall apply to the grass, shrubs and trees outside the Contract limits as shown on the Drawings.
- C. Protection of graded areas:
 - 1. Protect newly graded areas from traffic and erosion. Keep free of trash and debris.
 - 2. Repair and re-establish grades in settled, eroded and rutted areas to specified tolerances.
- D. Reconditioning compacted areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, reshape and compact to required density prior to further construction.
- E. Removal from Owner's property: During construction, debris shall be removed from site as soon as practical. See Section for specific removal instructions.

END OF SECTION 310000

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section is intended to include the provisions necessary to accomplish all site preparation work required by the Work.
- B. The types of work include, but are not limited to:
 - 1. Clearing, grubbing and disposal of materials and debris resulting from this work.
 - 2. Removing and disposing of above and below grade existing improvements.
 - 3. Tree salvage by Owner.
 - 4. Removal and lawful disposal of existing improvements to be removed or demolished for the Work.
- C. The area requiring site preparation work includes all areas within the Work limits as shown on the Drawings.
- D. Definitions:
 - 1. Clearing: The removal of trees, stumps, downtimber, shrubs, bushes, rubbish and other objectionable matter found at or above original ground level. Should Owner desire selective clearing, other than that shown on the Drawings, Owner will select and mark, or otherwise designate, the trees or ornamentals to remain standing at no additional cost to the Owner.
 - 2. Grubbing: The removal of stumps, roots, boards, logs and other objectionable debris found at or below original ground level.

1.2 JOB CONDITIONS

A. Protection:

- 1. Initiate and be responsible for all precautions reasonably necessary for the protection of the Work, protection of areas adjacent to, but outside the Work limits and for the protection of any persons whose injury might result from the failure to take such precautions.
- 2. Protect improvements at adjoining areas. Provide barricades, coverings or other types of protection necessary to prevent damage to existing improvements indicated to remain in place.
- 3. Provide for the protection of tops, trunks and roots of existing trees and flora that are to remain on Work site. Do not permit heavy equipment or stockpiles within branch spread.
- 4. Take all steps necessary to facilitate drainage and prevent water ponding in tree save areas.
- 5. Water grass, trees and other vegetation which are to remain within the limits of the Contract Work as required to maintain their health during the course of construction operations.
- 6. Restore any improvements damaged by this Work to their original or better condition, and repair or replace trees and vegetation damaged by construction operations in a manner acceptable to the Owner.

PART 2 - PRODUCTS

JFL – THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

Harris Civil Engineers

Project No. 07287000 SITE PREPARATIONS Section 31 10 01 - 1

2.1 MATERIALS

A. Provide all materials, equipment and appurtenances required for completion of clearing work, including that required for protection of vegetation and other improvements that are to remain.

PART 3 - EXECUTION

3.1 PERFORMANCE

- A. General:
 - 1. Remove all vegetation, improvements or obstructions in the areas indicated on the Drawings. Remove such items elsewhere on the site or premises as specifically indicated. Removal includes stumps and roots.
 - 2. Verify if the Owner desires to remove any trees prior to clearing.
- B. Clearing and grubbing:
 - 1. Clear and grub the site at new construction areas of all surface vegetation, roots, stumps, rubbish, and objectionable debris.
 - 2. Fill depressions caused by clearing and grubbing operations with satisfactory soil material.
 - 3. Remove all stumps, roots and matted roots to a depth of 12 inches
- C. Removal of Improvements: Remove above-grade and below-grade improvements necessary to permit construction and other work as indicated.
- D. Disposal
 - 1. Remove waste, unsuitable and excess materials from the site daily and dispose of legally at approved locations. Tree material may be kept on-site for up to five days.
 - 2. Burning is not permitted on the property without Owner's written approval.
- E. Selective Clearing and/or Grubbing
 - 1. Special attention shall be given by the Contractor to saving, protecting, and preserving any existing trees, shrubs or other vegetation so designated by the Owner. Selective clearing and/or grubbing shall be performed in locations indicated on the Drawings and other areas specified by the Owner at no additional cost to the Owner. The Owner or his representative will select and mark, or otherwise designate, trees, ornamentals or other vegetation to be preserved outside of the tree save areas shown in the Drawings. Contractor shall install and maintain, until directed otherwise by Owner, a temporary fence around such designated vegetation for a minimum of 10 feet beyond the drip line of the trees, ornamentals, or other vegetation to be preserved. Clearing limits must be approved by the Owner prior to beginning clearing operations.
 - 2. Many improvements located within tree saves will require selective clearing and grubbing within the tree save areas. These improvements include hardscape utilities, drainage, etc. These items are shown on the Drawings as to general location. However, exact locations will be determined by the Owner in the field. Vegetation remaining after these operations

JFL – THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

Harris Civil Engineers

Project No. 07287000 SITE PREPARATIONS Section 31 10 01 - 2 shall be protected by temporary fence and hay bales/silt fence in the same manner as the original exterior of the tree save area.

END OF SECTION 311001

Project No. 07287000

Section 31 10 01 - 3

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes all work required to complete, as indicated by the Contract Documents, and furnish all supplementary items necessary for the proper dewatering, excavating, shoring, sheeting, bracing, trenching, backfilling and all other earthwork operations required for utility and other underground lines and appurtenances.

1.2 RELATED SECTIONS

- A. Earthwork Section 310000
- B. Potable and Reuse Water Distribution Systems Section 331110

1.3 QUALITY ASSURANCE

- A Tests and inspections:
 - 1. Required tests:
 - 2. Backfill material: Determine suitability of backfill and bedding material not previously evaluated.
 - 3. Maximum density tests: Determine optimum moisture content and maximum density of backfill and bedding materials placed and compacted.
 - 4. Bedding conditions: Determine and evaluate condition of bedding to receive utility lines.
 - 5. Compaction inspection: Determine degree of backfill compaction.
- B Reference Specifications and Standards:
 - 1. ASTM D1557 Moisture-Density Relations of Soils, using 10 lb. Rammer and 18 inches Drop.
 - 2. AASHTO: T-180 (Modified Proctor).

PART 2 - PRODUCTS

2.1 BACKFILL MATERIAL

- A. TYPE A BACKFILL:
 - 1. Select bedding material shall be clean, well-graded, rounded coarse aggregate or crushed rock of 3/4-inch maximum size and 3/8-inch minimum size. When tested in accordance with ASTM D422 it shall conform to the following gradation requirements:

-	100 Percent
-	90-100 Percent
-	20-55 Percent
-	0-10 Percent
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JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 07287000 EXCAVATING & BACKFILLING FOR UTILITIES Section 31 23 34 - 1

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TYPE B BACKFILL: B.

1. Type B backfill shall be a select granular material, free from organic matter and of such size and gradation that desired compaction can readily be attained. When tested in accordance with ASTM D422, it shall conform to the following gradation requirements.

Passing a 1-1/2 inch sieve	-	95 Percent (Min.)
Passing a No. 200 sieve	-	10 Percent (Max.)
Coefficient of Uniformity	-	6 or Greater
Sand Equivalent	-	35 Percent or Greater

2. The maximum aggregate size shall not exceed 3 inches. This material may be clean natural sand or gravel, imported quarry waste or select excavated material, provided that such material consists of loam, sand, sandy clay loam, gravel or other materials of the GM/GC classification, as classified in accordance with ASTM D2487. The Contractor shall submit soil reports ten (10) days in advance of intended use for approval by the Engineer and the Owner.

ORDINARY BACKFILL: С.

Ordinary backfill shall be material obtained from the Contractor's excavations. Such 1. materials shall be free of debris, deleterious materials, broken concrete or paving materials, root masses, organic materials, boulders, rocks or stones larger than 3 inches and expansive soils.

D. DEFICIENCY OF BACKFILL:

Where excavated material is indicated as backfill (ordinary backfill) on the Drawings or 1. specified herein, and there is a deficiency due to the rejection of part of the material, the required quantity of sand, gravel or other approved backfill material (Type A or B backfill) shall be obtained from a source secured by the Contractor and approved by the Owner.

PART 3 - EXECUTION

3.1 PROTECTION

- A. Protect from damage, all existing on-site features scheduled or indicated to remain, including trees and other flora.
 - Do not allow earthmoving equipment within the branch spread perimeter (drip line) of 1. existing trees.
 - 2. Do not cut tree roots over 2 inches in diameter without prior approval.
 - Support trees during excavation in an approved manner. 3.
- B. Where utility line excavation occurs in lawn, grassed or landscaped areas, carefully remove and stockpile sod and plants to preserve them for transplanting.

JFL - THS 5 ACRE LAND LEASE SITE	l.	Project No. 07287000
Procurement Package		EXCAVATING & BACKFILLING
07/21/2023		FOR UTILITIES
	Harris Civil Engineers	Section 31 23 34 - 2

- 1. Excavated material from trenches may be placed on the lawn or grass provided a drop cloth or other approved method is employed to protect the lawn or grass from permanent damage. Do not keep stockpiled materials on lawn or grass for more than 72 hours.
- 2. Immediately after completion of backfilling and testing of utility lines, replace sod and replant plants in a manner so as to restore the lawn, grass and landscaping to its original condition. Replace damaged landscaping as part of the work of this Section.
- C. Where utility line excavation occurs in paved areas, saw-cut the existing pavement along straight, uniform lines such that the amount of pavement cut and removed shall be the minimum consistent with safe excavation practices.
 - 1. Do not use removed pavement or base material as backfill.
 - 2. Replace removed pavement with new pavement to match existing in accordance with the Drawings and these Specifications.
- D. Maximum length of open trenches: 350 feet. Cover or barricade all open trenches during work hours and at the close of each work day. All guest areas shall be separated from open trenches by construction fencing at all times.
- E. Utilities:
 - 1. Where excavation for utility lines occurs near existing utilities, whether indicated or not on the Drawings, the Contractor shall be responsible to maintain existing utility services fully operational. Protect and support utility lines in a manner to prevent any damage. Method of protection is subject to utility's approval.
 - 2. In the event that damage does occur, make repairs or replacement immediately in an approved manner, as part of work of this Section.
 - 3. Remove abandoned lines encountered during excavating and dispose of off site.

3.2 PIPELINE TRENCH CONSTRUCTION

- A. Trench excavating and backfilling, including sheeting, shoring, bracing, dewatering, foundation, bedding and compaction, and the furnishing and disposal of material shall be performed in such a manner as to promote the safe and expedient execution of the work.
 - 1. It shall be the Contractor's responsibility to contact utilities not less than five (5) working days prior to the commencement of trenching and excavation to obtain an excavation permit and to locate and flag all existing underground utilities at the work site.
 - 2. The excavation and preparation of trenches shall not proceed in advance of pipe installation more than 100 feet, except as approved by the Owner. Trenching shall not, under any conditions, exceed the quantity of pipe that can be bedded, inspected, tested, backfilled and compacted in one working day.
 - 3. All excavations shall be made by open cut unless indicated otherwise in these Specifications or on the Drawings.
 - 4. Excavation in close proximity to existing utilities shall be performed in such a manner, so as to prevent damage to the lines.

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 07287000 EXCAVATING & BACKFILLING FOR UTILITIES Section 31 23 34 - 3

- 5. The sides of trenches shall be kept as nearly vertical as possible from the trench bottom to a level 1 foot above the top of the pipe.
- 6. The trench bottom shall be excavated to true line and grade and shall not be less than 18 inches wide nor more than 24 inches wider than the outside diameter of the pipe, so that a clear space of from 9 to 12 inches is provided on each side of the pipe.
- 7. The minimum trench width for pipe 6 inches and smaller shall not be less than 24 inches.
- 8. When obstructions that are not shown on the Drawings are encountered during the progress of the work that interfere such that a revision to the Drawings is required, the Engineer, with the approval of the utility, will revise the Drawings, or order the removal, relocation or reconstruction of the obstruction.
- 9. Excavated material shall not be placed in any manner that will obstruct the Work or endanger the workmen, obstruct sidewalks, entrances, streets or structures. Excavation and placement of excavated materials shall comply with all federal, state and local regulations.
- 10. Removal of pavement and roadway surfaces shall be a part of the trench excavation. Pavement shall be saw cut to insure the breaking of the pavement along straight lines. Broken pavement and unsuitable soils from the excavation shall be removed from the work site.
- 11. Roadway cuts shall be made between the hours of 2 a.m. and 6 a.m. to minimize disruption of traffic. Roadways shall be in safe operating condition no later than 7:00 a.m. The Contractor shall provide safe, temporary detours for traffic during open cut construction.
- 12. When the subgrade is found to contain materials such as ashes, cinders, refuse, broken concrete, logs, root masses, organic material or other unsuitable or unstable material, the Contractor shall remove all such material to a minimum of 6 inches below the trench bottom elevation, and replace with clean stable backfill material.
- 13. Blasting and the use of explosives shall not be permitted.
- 14. Boring and jacking, where required, shall be conducted with no interference with traffic, even if this should require that the work be done between the hours of 2 a.m. and 6 a.m.
- 15. Trees, shrubs, fences, structures and other property shall be protected during construction unless their removal or demolition is shown on the Drawings or called for in the Specifications.
 - a. Cutting of tree roots or branches shall be performed only as specified and approved by the Owner.
 - b. Temporary support, adequate protection and maintenance of all underground and surface structures, drains, sewers, water mains, force mains, electrical and communications and other obstructions encountered in the progress of the work shall be the responsibility of the Contractor.
 - c. All properties that have been disturbed in the course of the work shall be restored to their original condition.

3.3 SHEETING, SHORING AND BRACING

A. The Contractor shall furnish, install and maintain sheeting, bracing and shoring required to support the sides of the excavation, and to prevent any movement which may damage adjacent utilities, pavements or structures, damage or delay the work or endanger life and health. All voids outside the supports shall be immediately filled and compacted.

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 07287000 EXCAVATING & BACKFILLING FOR UTILITIES Section 31 23 34 - 4

- B. All sheeting, bracing and shoring to be used shall be designed by a Registered Professional Engineer, and shall be in accordance with OSHA Standard 1926-606, Subpart P, Excavation, Trenching and Shoring and the Trench Safety and Health Act.
- C. Where it is impractical to remove shoring and bracing, obtain approval to leave it in place. Record locations of such "in place" shoring and bracing on project record documents.
- D. Wood sheeting left in place shall be pressure treated. Prior to abandonment, the sheeting shall be cut to a level at least 30 inches below finished grade.
- E. Steel sheeting left in place shall be as specified in ASTM A328. Prior to abandonment, the sheeting shall be cut to a level at least 30 inches below finished grade.

3.4 DEWATERING AND DRAINAGE

A. All piping shall be laid "in the dry" unless otherwise approved by the Owner. All dewatering shall conform to the requirements of Dewatering Specification.

3.5 TRENCH STABILIZATION

- A. When the trench bottom is found to contain unsuitable material which is unstable to such a degree that in the judgment of the Engineer it cannot be removed, a foundation for the pipe, structure and/or appurtenance shall be constructed using piling, treated timber, concrete or other material approved by the Engineer.
 - 1. Unsuitable materials are soils, exposed at the trench bottom that are compressible, expansive, contain extraneous rubble, offer uneven foundation support, or have a natural moisture content 3 percent in excess of the soils optimum moisture content.
 - 2. Unsuitable materials/soils shall include, but not be limited to, muck, peat, expansive clays, boulders, soils in a quick condition, rubble, any portion of trees, roots or similar vegetation, wood or other unyielding material.
- B. The Contractor shall notify the Engineer immediately when unstable material is encountered. The Engineer will investigate the questionable material to determine its stability.
 - 1. Where the Engineer determines that unstable material is present below the pipe envelope which will not provide adequate support for the pipe, the Contractor shall remove the unstable material and replace with a minimum of 6 inches of Type A backfill up to the bottom of the pipe envelope.

3.6 BACKFILLING, COMPACTION AND TESTING

A. The Contractor shall not perform any backfilling operations other than those that are necessary to hold the pipe in place until soil test samples have been taken, locations recorded, the pipeline tested, inspected and released for backfilling.

B. BEDDING:

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 07287000 EXCAVATING & BACKFILLING FOR UTILITIES Section 31 23 34 - 5

JFL St Croix

1. See specific utility sections for bedding details.

C. HAUNCHING:

- 1. After the pipe has been properly bedded and inspected, ordinary backfill, as specified in 2.01C. of this Section, as available, or Type B backfill shall be carefully placed and compacted, under and around the pipe, up to the springline of the pipe.
 - a. Ordinary or Type A or B backfill material shall be placed in loose horizontal lifts equally on both sides of the pipe. Lifts shall not exceed 6 inches in loose depth.
 - b. The backfill material shall be spaded, walked-in and compacted with hand tampers to obtain a relative density of not less than 95 percent of the maximum density as determined by ASTM D1557.
 - c. When one lift is completed and compacted on both sides of the pipe, subsequent lifts shall be placed and compacted up to the springline of the pipe.

D. PIPE ENVELOPE:

- 1. After haunching has been placed, compacted, inspected, tested and accepted, ordinary backfill (as available) or Type A or B backfill shall be carefully placed around and over the pipe in loose horizontal lifts not to exceed 12 inches in depth.
 - a. The backfill material shall be walked-in and compacted with tampers to obtain a relative density of 90 percent of the maximum density. Where trench depths are 6 feet or less to the top of the pipe, the minimum allowable relative density shall not be less than 95 percent of the maximum density.
 - b. When the first lift is compacted and complete, subsequent lifts shall be placed and compacted until the pipe envelope is complete to 1 foot above the pipe.

E. BACKFILL AND COMPACTION:

- 1. Above the level of the pipe envelope, the trench shall be backfilled with ordinary backfill, placed in horizontal lifts and compacted by power operated tampers or vibratory equipment. The Contractor shall compact each successive lift to the specified relative density prior to placing subsequent 1 foot maximum lifts.
- 2. The Contractor shall not achieve compaction by the use of heavy rolling equipment or by running heavy construction equipment on or in the trench. Backfilling and compaction shall have been completed, tested and the degree of compaction verified before heavy equipment is operated over the trench.
- 3. Compaction tests shall, at a minimum, be conducted every 100 feet.
- 4. Puddling or flooding with water to achieve compaction shall not be permitted.
- 5. When unsatisfactory compaction is revealed, the Contractor shall immediately re-excavate the trench from the unsatisfactory area to the nearest points of satisfactory compaction testing, replace and re-compact the backfill to the required relative densities over the entire depth of the trench.

F. PARTIAL BACKFILL DURING TESTING:

JFL - THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 07287000 EXCAVATING & BACKFILLING FOR UTILITIES Section 31 23 34 - 6

1. When conditions require that pipe testing should be accomplished before completion of backfilling or with pipe joints accessible for examination, sufficient backfill material shall be placed over the pipe barrel, between the joints to prevent pipe movement.

3.7 ADJUSTMENT AND CLEANING

- A. Surface restoration:
 - 1. Restore surfaces areas over trenches equal to conditions which existed prior to start of work or better.
 - 2. Reconstruct surfaces in accordance with applicable sections of the Specifications.
- B. Disposal:
 - 1. Debris: Remove and dispose of all rubbish, debris, and vegetation as they accumulate.
 - a. Dispose of debris off site.
 - b. Excess soil: Stockpile on a site approved by the Engineer and Owner

END OF SECTION 312334

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes all work required to complete, as indicated by the Contract Documents, and furnish all supplementary items necessary for the proper installation of the structure subgrade.
- B. Section includes:
 - 1. Excavating, backfilling and compacting for structures.
 - 2. Restore grades to required elevations.
 - 3. Remove excess materials from site.
 - 4. Pumping and dewatering.
 - 5. Sheeting of excavations.

1.2 RELATED SECTIONS

- A. Earthwork Section 310000
- B. Excavating and Backfilling for Utilities Section 312334

1.3 QUALITY ASSURANCE

- A. Tests and inspections:
 - 1. Test methods:
 - a. Maximum density of backfill materials will be determined by ASTM D1557 Method A (5-layer method), unless other applicable method is approved.
 - b. Field density tests will be determined by ASTM D2922 (Nuclear method), or ASTM D1556 (sand-cone method), unless other applicable method is approved.
 - 2. Required tests:
 - a. Backfill material: Determine suitability of backfill and bedding material not previously evaluated.
 - b. Maximum density tests: Determine optimum moisture content and maximum density of backfill and bedding materials placed and compacted.
 - c. Compaction inspection: Determine degree of backfill compaction.
- B. Reference specifications and standards:
 - 1. ASTM: D2922 (Nuclear method), or ASTM D1556 (sand-cone method).
 - 2. ASTM D1557 Moisture-Density Relations of Soils, using 10 lb. Rammer and 18 inches Drop.

JFL – THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 07287000 EXCAVATING & BACKFILLING FOR STRUCTURES Section 31 23 35 - 1

PART 2 - PRODUCTS

2.1 MATERIALS

- A. On-site and borrow materials:
 - 1. Conforming to these specifications.

PART 3 - EXECUTION

3.1 PROTECTION

- A. Protect public and adjacent properties, on and off site, in accord with applicable laws and ordinances. Protect and provide fencing as detailed in the <u>drawings</u>
- B. Protect from damage, all existing on-site features scheduled or indicated to remain, including flora scheduled to remain.
 - 1. Do not allow earthmoving equipment within the branch spread perimeter (drip line) of existing trees.

C. Utilities:

- 1. Protect and support active utility lines in a manner to prevent damage. Methods subject to Owner's approval.
- 2. Remove abandoned lines encountered during excavation and dispose of off-site.
 - a. Report unidentified lines to Owner for determination as to "dry" or "abandoned" prior to removal.
- 3. Capping and rerouting of indicated active utility lines encountered during grading operations will be performed as part of the work of this section.
- D. Cribbing and shoring:
 - 1. Provide temporary or permanent cribbing, sheeting and shoring as necessary to safely retain earth banks and protect excavations from caving or other damage.
 - 2. Be responsible for design, installation and maintenance of cribbing, sheeting and shoring. Remove temporary cribbing and shoring after use.

3.2 STRIPPING

- A. Stockpile materials from excavations suitable for use in fill and backfill.
- B. Materials not approved for use as topsoil, fill or backfill, and excess excavating materials shall be removed from site and disposed of properly, subject to Owner's written approval.

3.3 EXCAVATING

A. Excavate materials of every nature to dimensions and elevations indicated. Use equipment of

Harris Civil Engineers

JFL – THS 5 ACRE LAND LEASE SITE
Procurement Package
07/21/2023

Project No. 07287000 EXCAVATING & BACKFILLING FOR STRUCTURES Section 31 23 35 - 2 suitable type for materials and conditions involved.

- B. Extend excavation a sufficient distance from walls to allow for forming and shoring, application of waterproofing, installation of services and approvals. Do not excavate below indicated depths.
- C. Correct unauthorized excavation made below depths indicated, as recommended by soils engineer at no additional cost to Owner.

3.4 FILL, BACKFILL AND COMPACTION

- A. Fill and backfill:
 - 1. Place fill and backfill in layers that will uniformly compact to the required densities, but not in loose layers more than 12-15 inches thick.
 - a. Place backfill only after walls are supported by completion of interior floor systems or are braced to resist the imposed loading.
 - b. Place backfill against walls below grade after waterproofing systems have been completed and approved.
 - c. Protect waterproofing systems during backfill operations.
 - d. If waterproofing is damaged, do not continue backfilling until damage is repaired as approved by Owner.
 - 2. Restore grades to indicated elevations.
- B. Compaction:
 - 1. Proof roll existing ground prior to filling.
 - 2. Bring each layer to optimum moisture content before compaction. Add water by uniform sprinkling.
 - 3. When moisture content and condition of each layer is satisfactory, compact to not less than 95% of maximum density.
 - a. Compact areas not accessible to motor-driven equipment with mechanical or heavy hand tampers.
 - 4. Rework compacted areas failing to meet specified maximum density, as determined by tests. Re-compact and re-test as required to achieve 95% maximum density.

END OF SECTION 312335

1.1 DESCRIPTION

- A. Erosion and sedimentation control requirements:
 - 1. All erosion, sedimentation and water pollution control features shall be in place or relocated as designated on the plans prior to the start of any clearing, grubbing, grading or construction. Contractor shall be responsible for the installation and maintenance of all temporary erosion control features.
 - 2. Location of the control features shall be in accordance with the Drawings or as required to facilitate drainage and control erosion and sedimentation within and adjacent to the site.
 - 3. Control features are defined as, but not limited to, swales, berms, silt fences, silt barriers and temporary fences.

1.2 SUBMITTALS

- A. Product data: Manufacturers literature, application instructions and samples.
- B. List of materials and their characteristics for other erosion control items.
- C. Erosion control plan.

1.3 CONTROL OF CONTRACTOR'S OPERATIONS WHICH MAY RESULT IN WATER POLLUTION

- A. Take sufficient precautions to prevent pollution of streams, canals, lakes, reservoirs, wetlands and other sensitive areas with silt, sediment, fuels, oils, bitumens, calcium chloride, or other harmful materials. Conduct and schedule operations so as to avoid or otherwise minimize pollution or siltation of such streams, etc. and to avoid interference with movement of migratory fish. Do not dump the residue from dust collectors or washers into any water body.
- B. Construction operations in rivers, streams, lakes, tidal waters, reservoirs, canals, and other impoundments shall be restricted to those areas where it is necessary to perform filling or excavation to accomplish the work shown in the Contract Documents and to those areas which must be entered to construct temporary or permanent structures. As soon as conditions permit, promptly clear rivers, streams, and impoundments of all obstructions placed therein or caused by construction operations.
- C. Except as necessary for construction, do not deposit excavated material in rivers, streams, canals, or impoundments, or in a position close enough thereto, to be washed away by high water or run-off.

JFL – THS 5 ACRE LAND LEASED SITE Procurement Package 07/21/2023 Project No. 07287000 EROSION & SEDIMENT CONTROL Section 31 25 00 - 1
- D. Where pumps are used to remove highly turbid waters from enclosed construction areas such as cofferdams or forms, treat the water prior to discharge into waterways. Pump the water into grassed swales, appropriately vegetated areas, or sediment basins, or confine it by an appropriate enclosure such as siltation curtains when other methods are not considered appropriate. Do not contaminate waterways.
- E. Do not disturb lands or waters outside the limits of construction, unless approved in advance and in writing by the Owner. No operations within non-permitted wetlands or upland buffers are allowed.

1.4 START OF WORK

A. Do not start work until erosion control measures are in place.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Silt Barriers:
 - 1. Two types of silt barriers shall be installed in accordance with the plans: silt barriers installed on the ground and floating silt barriers.
 - 2. Silt barriers (filter fabric) shall be synthetic and contain ultraviolet ray inhibitors and stabilizers to provide a minimum of six (6) months of expected usable construction life at a temperature range of 0 to 120 degrees F.
 - 3. Filter fabric shall be a pervious sheet of propylene, nylon or polyester and shall be certified by the manufacturer or supplier to conform to the following specifications:

Filter efficiency (Test VTM-51): 75 percent.

Minimum tensile strength at 20 percent elongation (<u>Test ASTM D 5034 and 5035</u>): 120 pounds.

Tear strength: 50 pounds.

- 4. Contractor shall submit filter fabric material specifications and installation configuration prior to start of construction.
- 5. Silt barriers shall be maintained in place and shall become the property of Owner.
- 6. Filter fabric shall be purchased in a continuous roll cut to the length of the barrier to avoid the use of joints. When joints are necessary, filter fabric shall be spliced together only at a support post, with a 6 inch overlap, and securely sealed.
- 7. The following items shall be installed and maintained in accordance with the applicable sections of the FDOT and local government Standard Specifications:
 - a. Temporary silt fences and staked silt barriers
 - b. Floating silt barrier
- 8. Temporary Fence
 - a. Brightly colored fence as manufactured by Mirafi, product Mirasafe, or approved equal.
 - b. Material shall be 4 feet high, attached to 6 feet metal posts at 12 feet centers. Posts

JFL – THS 5 ACRE LAND LEASED SITE
Procurement Package
07/21/2023

Project No. 07287000 EROSION & SEDIMENT CONTROL Section 31 25 00 - 2 shall be driven 18 inches into ground.

PART 3 - EXECUTION

3.1 GENERAL

- A. Temporary erosion control features shall consist of, but not be limited to, temporary grassing, temporary sodding, temporary mulching, sandbagging, slope drains, sediment basins, artificial coverings, berms, baled hay or straw, floating silt barriers, staked silt barriers and staked silt fences. Design details for some of these items may be found in the Water Quality Section of the applicable edition of the FDOT Roadway and Traffic Design Standards. All of these items shall be constructed in accordance with applicable sections of the FDOT Standard Specifications for Road and Bridge Construction.
- B. Incorporate permanent erosion control features into the Work at the earliest practical time. Correct conditions, using temporary measures, that develop during construction to control erosion prior to the time it is practical to construct permanent control features.
- C. Construct temporary and permanent erosion and sediment control measures and maintain them to prevent the pollution of adjacent water ways in conformance with the laws, rules and regulations of Federal, State and local agencies.
- D. Copies of approved permits will be provided to the Contractor for his review and use. Contractor shall be required to comply with all General and Special Conditions noted within the permit by the particular permitting agency. The Contractor shall maintain copies of these permits on the job site at all times.

3.2 INSTALLATION

- A. The following items shall be installed in accordance with the FDOT Standard Specifications for Road, Bridge and Utility Construction. The procedures are only generally described herein.
 - 1. Temporary Grassing: This work shall consist of furnishing and placing grass seed.
 - 2. Temporary Sod: This work shall consist of furnishing and placing sod.
 - 3. Temporary Mulching: This work shall consist of furnishing and applying a two-inch to fourinch thick blanket of straw or hay mulch and then mixing or forcing the mulch into the top two inches of the soil in order to temporarily control erosion. Only undecayed straw or hay, which can readily be cut into the soil, shall be used. Other measures for temporary erosion control such as hydro-mulching, chemical adhesive soils stabilizers, etc., may be substituted for mulching with straw or hay with the approval of the Owner. When permanent grassing operations begin, temporary mulch materials shall be plowed under in conjunction with preparation of the ground.
 - 4. Sandbagging: This work shall consist of furnishing and placing sandbags in configurations, so as to control erosion and siltation.

JFL – THS 5 ACRE LAND LEASED SITE Procurement Package 07/21/2023 Project No. 07287000 EROSION & SEDIMENT CONTROL Section 31 25 00 - 3

- 5. Slope Drains: This work shall consist of constructing slope drains, utilizing pipe, fiber mats, rubble, cement concrete, asphaltic concrete plastic sheeting, or other acceptable materials, in accordance with the FDOT Roadway and Traffic Design Standards or as may be approved as suitable to adequately perform the intended function.
- 6. Sediment Basins: Sediment basins shall be constructed in accordance with the details shown in FDOT Roadway and Traffic Design Standards or as suitable to adequately perform the intended function. Sediment basins shall be cleaned out as necessary.
- 7. Artificial Coverings: This work shall consist of furnishing and applying fiber mats, netting, plastic sheeting, or other approved covering to the earth surfaces.
- 8. Berms: This work shall consist of construction of temporary earth berms to divert the flow of water from an erodible surface.
 - a. This work shall consist of construction of baled hay or straw dams or earth berms to protect against downstream accumulations of silt. The baled hay or straw dams shall be constructed in accordance with the details shown in FDOT Roadway and Traffic Design Standards.
 - b. The berm or dam shall be placed so as to effectively control silt dispersion under conditions present on this Work. Alternate solutions and usage of materials may be used if approved.

3.3 SILT BARRIERS

- A. Silt barriers shall be installed and maintained at the locations shown on the plans. The Contractor is required to prevent the possibility of silting onto any adjacent parcel.
- B. Silt barrier shall be of the staked type and stakes shall be installed as indicated in the drawings.
- C. The height of the silt barrier fabric shall be a minimum of 42 inches.
- D. The stakes shall be 2 inch x 4 inch wood, 5 feet long and shall be spaced a maximum of 10 feet apart at the barrier location and driven securely into the ground.
- E. A trench shall be excavated approximately 4 inches wide by 4 inches deep along the line of stakes. The filter fabric shall be tied or stapled to the wooden stakes and 8 inches of fabric shall be extended into the trench. The staples shall be heavy duty wire and at least 1/2 inch long. The trench shall then be backfilled and the soil compacted over the filter fabric.

3.4 FLOATING SILT BARRIERS

A. Floating silt barriers shall be located as shown on the Drawings and shall be in place prior to the start of any construction or grading.

B. Floating silt barriers shall meet or exceed the FDOT Roadway and Traffic Design Standards, Index No. 103, Floating Silt Barrier. Contractor shall submit filter fabric material specifications and installation configuration for approval prior to the start of construction.

3.5 TEMPORARY FENCE

- A. Furnish, install and maintain on wetland lines, buffer lines, tree save lines and otherwise as shown on plans. Attach silt barrier to the temporary fence.
- B. Follow manufacturer's installation recommendations.

3.6 MAINTENANCE

- A. Silt barriers and temporary fences shall be inspected immediately after each rainfall and at least once a day during periods of prolonged rainfall. Any repairs shall be made immediately.
- B. Should the fabric on a silt barrier or temporary fence decompose or become ineffective, the installation shall be repaired or replaced immediately at no additional cost to the Owner. If the Contractor fails to repair or replace the items as above, the Owner shall have the right to stop work without additional cost to the Owner until such time as the repair or replacement has been made.
- C. Sediment deposits shall be removed after each storm event. The Contractor will repair and restore the installations to a working and effective condition to the satisfaction of the Owner.
- D. At the completion of all work, the silt barriers and the temporary fences will be removed and disposed by the Contractor if directed by the Owner.
- E. Any sediment deposits in place after the silt fence or filter barrier is no longer required shall be dressed to conform to the existing grade and prepared for seeding or sodding.

3.7 PROTECTION DURING SUSPENSION OF CONTRACT TIME

A. In the event that it is necessary that the construction operations be suspended for any appreciable length of time, shape the top of the earthwork in such a manner as to permit run-off of rainwater and construct earth berms along the top edges of embankments to intercept run-off water. Provide temporary slope drains to carry run-off from cuts and embankments which are located in the vicinity of rivers, streams, canals, lakes and impoundments. Should such preventative measures fail, immediately take such other action as necessary to effectively prevent erosion and siltation.

END OF SECTION 312500

JFL – THS 5 ACRE LAND LEASED SITE Procurement Package 07/21/2023 Project No. 07287000 EROSION & SEDIMENT CONTROL Section 31 25 00 - 5

PART 1 - GENERAL

1.1 COMPOSITION

- A. Coarse aggregate shall consist of naturally occurring materials such as gravel, or resulting from the crushing of parent rock, to include natural rock, slags, expanded clays and shales (lightweight aggregates) and other approved inert materials with similar characteristics, having hard, strong, durable particles, conforming to the specific requirements of this Section.
- B. Coarse aggregate for use in nonstructural concrete applications or hot bituminous mixtures may also consist of reclaimed Portland cement concrete meeting the requirements of Part 5. Washing of this material will not be required if the requirements of Section 1.2 for maximum percent of material passing the No. 200 sieve can be met without washing.
- C. Materials substantially retained on the No. 4 sieve, shall be classified as coarse aggregate.
- D. Approval of mineral aggregate sources shall be in accordance with specification.

1.2 DELETERIOUS SUBSTANCES

A. All coarse aggregates shall be reasonably free of clay lumps, soft and friable particles, salt, alkali, organic matter, adherent coatings, and other substances not defined which may possess undesirable characteristics. The weight of deleterious substances shall not exceed the following percentages:

Coal and lignite (AASHTO T 113)1.00
Soft and friable particles (AASHTO T 112)*2.00
Clay lumps (AASHTO T 112)*2.00
Plant root matter (visual inspection in
AASHTO T 27)****
Wood and wood matter (visual inspection in
AASHTO T 27)****0.005
Cinders and clinkers0.50
Free shell**
Total Material passing the No. 200 sieve (FM 1-T 011) At
Source with Los Angeles Abrasion less than or equal
to 302.50
At Source with Los Angeles Abrasion greater than
30
At Point of Use
Fine-Grained Organic Matter (AASHTO 194)0.03
Chert (less than 2.40 specific gravity SSD)
(A A SUTO T 112)*** 2 00

*The maximum percent by weight of soft and friable particles and clay lumps together shall not exceed 3.00.

**Aggregates to be used in asphalt concrete may contain up to 5% free shell. Free shell is defined as that portion of the coarse aggregate retained on the No. 4 sieve consisting of loose, whole, or broken shell, or

the external skeletal remains of other marine life, having a ratio of the maximum length of the particle to the shell wall thickness exceeding five to one. Coral, molds, or casts of other shells, and crushed clam and oyster shell indigenous to the formation

will not be considered as free shell.

***This limitation applies only to coarse aggregates in which chert appears as an impurity. It is not applicable to aggregates which are predominantly chert.

****Plant root matter, and wood and wood matter shall be considered deleterious when any piece exceeds two inches in length or 1/2 inch in width.

1.3 PHYSICAL PROPERTIES

A. Coarse aggregates shall meet the following physical property requirements, except as noted herein:

Los Angeles Abrasion (FM 1-T 096)	Maximum loss 45%
Soundness (Sodium Sulfate) AASHTO T104	Maximum loss 12%*
Flat or elongated pieces**	

*For source approval - Aggregates exceeding soundness loss limitations will be rejected unless performance history shows that the material will not be detrimental for Portland Cement Concrete or other intended usages.

**A flat or elongated particle is defined as one having a ratio between the maximum and the minimum dimensions of a circumscribing prism exceeding five to one.

1.4 GRADATION:

A. Coarse aggregates shall conform to the gradation requirements of Table 1, when the stone size is specified. However, Table 1 is waived for those aggregates intended for usage in bituminous mixtures, provided the material is graded on sieves specified in production requirements contained in this specification, and meets uniformity and bituminous design requirements.

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	TABLE 1								
	Standard Sizes of Coarse Aggregate								
	Amounts Finer than Each Laboratory Sieve (Square Openings), weight percent								
Size No.	Nominal Size Square Openings	$\begin{array}{c c c c c c c c c c c c c c c c c c c $							
1	3 1/2 to 1 1/2 inches	100	90 to 100	-	25 to 60	-	0 to 15	-	
2	2 1/2 inches to 1 1/2 inches	-	-	100	90 to 100	35 to 70	0 to 15	-	
24	2 1/2 inches to 3/4 inch	-	-	100	90 to 100	-	25 to 60	-	
3	2 inches to 1 inch	-	-	-	100	90 to 100	35 to 70	0 to 15	
357	2 inches to No. 4	-	-	-	100	95 to 100	-	35 to 70	
4	1 1/2 inches to 3/4 inch	-	-	-	-	100	90 to 100	20 to 55	
467	1 1/2 inches to No. 4	-	-	-	-	100	95 to 100	-	
5	1 inch to 1/2 inch	-	-	-	-	-	100	90 to 100	
56	1 inch to 3/8 inch	-	-			-	100	90 to 100	
57	1 inch to No. 4	-	-	-	-	-	100	95 to 100	
6	3/4 inch to 3/8 inch	-	-	-	-	-	-	100	
67	3/4 inch to No. 4	-	-	-	-	-	-	100	
68	3/4 inch to No. 8	-	-	-	-	-	-	-	
7	1/2 inch to No. 4	-	-	-	-	-	-	-	
78	1/2 inch to No. 8	-	-	-	-	-	-	-	
8	3/8 inch to No. 8	-	-	-	-	-	-	-	
89	3/8 inch to No. 16	-	-	-	-	-	-	-	
9	No. 4 to No. 16	-	-	-	-	-	-	-	
10	No. 4 to 0	-	-	-	-	-	-	-	

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	TABLE 1 (Continued) Standard Sizes of Coarse Aggregate							
	Amounts Finer that	an Each Lab	oratory Sie	eve (Square	Openings),	weight per	cent	
Size No.	Nominal Size Square Openings	3/4 inch	1/2 inch	3/8 inch	No. 4	No. 8	No. 16	No.50
1	3 1/2 inches to 1 1/2 inches	0 to 5	-	-	-	-	-	-
2	2 1/2 inches to 1 1/2 inches	0 to 5	-	-	-	-	-	-
24	2 1/2 inches to 3/4 inch	0 to 10	0 to 5	-	-	-	-	-
3	2 inches to 1 inch	-	0 to 5	-	-	-	-	-
357	2 inches to No. 4	-	10 to 30	-	0 to 5	-	-	-
4	1 1/2 inches to 3/4 inch	0 to 15	-	0 to 5	-	-	-	-
467	1 1/2 inches to No. 4	35 to 70	-	10 to 30	0 to 5	-	-	-
5	1 inch to 1/2 inch	20 to 55	0 to 10	0 to 5	-	-	-	-
56	1 inch to 3/8 inch	40 to 85	10 to 40	0 to 15	0 to 5	-	-	
57	1 inch to No. 4	-	25 to 60	-	0 to 10	0 to 5	-	-
6	3/4 inch to 3/8 inch	90 to 100	20 to 55	0 to 15	0 to 5	-	-	-
67	3/4 inch to No. 4	90 to 100	-	20 to 55	0 to 10	0 to 5	-	-
68	3/4 inch to No. 8	90 to 100	-	30 to 65	5 to 25	0 to 10	0 to 5	-
7	1/2 inch to No. 4	100	90 to 100	40 to 70	0 to 15	0 to 5	-	-
78	1/2 inch to No. 8	100	90 to 100	40 to 75	5 to 25	0 to 10	0 to 5	-
8	3/8 inch to No. 8	-	100	85 to 100	10 to 30	0 to 10	0 to 5	-
89	3/8 inch to No. 16	-	100	90 to 100	20 to 55	5 to 30	0 to 10	0 to 5
9	No. 4 to No. 16	-	-	100	85 to 100	10 to 40	0 to 10	0 to 5
10	No. 4 to 0	-	-	100	85 to 100	-	-	-

NOTE: The gradations in Table 1 represent the extreme limits for the various sizes indicated, which will be used in determining the suitability for use of coarse aggregate from all sources of supply. For any grade from any one source, the gradation shall be held reasonably uniform and not subject to the extreme percentages of gradation specified above.

PART 2 - NATURAL STONES

2.1 NATURAL STONES

A. Course aggregate may be processed from gravels, granites, limestones, dolomite, sandstones, or other naturally occurring hard, sound, durable materials meeting the requirements of this Section.

2.2 GRAVELS

- A. Gravel shall be composed of naturally occurring quartz, free from deleterious coatings of any kind. The minimum dry-rodded weight AASHTO T 19 shall be 95 lb/ft3.
- B. Crushed gravel shall consist of a minimum of 85%, by weight, of the material retained on the No. 4 sieve, having at least three fractured faces.

2.3 GRANITES

A. Coarse aggregate produced from the crushing of granites shall be sound and durable. For granites to be used in bituminous mixtures and surface treatments, the Los Angeles Abrasion requirement of 901-1.3 is modified to permit a maximum loss up to 50 (FM 1-T 096). Maximum amount of mica schist permitted is 5% (FM 5-584).

2.4 LIMESTONES, DOLOMITE AND SANDSTONE

- A. Coarse aggregates may be produced from limestone, dolomite, sandstones, and other naturally occurring hard, durable materials meeting the requirements of this Section.
- B. Pre-Cenozoic limestones and dolomite shall not be used as crushed stone aggregates either coarse or fine for Asphalt Concrete Friction Courses, or any other asphalt concrete mixture or surface treatment serving as the final wearing course. This specifically includes materials from the Ketone Dolomite (Cambrian) Newala Limestone (Mississippian), and Northern Alabama and Georgia.
- C. As an exception to the above up to 20% fine aggregate from these materials may be used in asphalt concrete mixtures other than Friction Courses which serve as the final wearing course.

2.5 CEMENTED COQUINA ROCK

A. For Cemented Coquina Rock to be used in bituminous mixtures, the Los Angeles Abrasion requirement of 901-1.3 is modified to permit a maximum loss up to 50 (FM 1-T 096) provided that the amount of material finer than No. 200 generated during the Los Angeles Abrasion test is less than 18%.

PART 3 - MANUFACTURED STONES

3.1 SLAGS:

A. Coarse aggregate may be produced from molten nonmetallic by-products consisting essentially of silicates and aluminosilicates of calcium and other bases, such as air- cooled blast-furnace slag or phosphate slag, provided it is reasonably uniform in density and quality, and reasonably free from deleterious substances as specified in 901-1.2. In addition, it must meet the following specific requirements:

Sulphur content	not more than 1.5%
Dry rodded weight AASHTO T 19	\dots minimum 70 lb/ft ³
Glassy Particles	not more than 10%
Slag shall not be used as an aggregate for Por	rtland cement concrete.

B. For Air-Cooled Blast Furnace Slag, the Los Angeles Abrasion requirement of 901-1.3 is modified to permit a maximum loss up to 50 (FM 1-T 096) provided that the amount of material finer than No. 200 sieve generated during the Los Angeles Abrasion test is less than 18%.

PART 4 - LIGHTWEIGHT AGGREGATES

4.1 LIGHTWEIGHT COARSE AGGREGATE FOR BITUMINOUS CONSTRUCTION

A. Lightweight coarse aggregate may be produced from naturally occurring materials such as pumice, scoria and tuff or from expanded clay, shale or slate fired in a rotary kiln. It shall be reasonably uniform in quality and density, and free of deleterious substances as specified in 901-1.2, except that the term cinders and clinkers shall apply to those particles clearly foreign to the extended aggregate in question.

In addition, it must meet the following specific requirements:

Material passing the No. 200 Sieve	maximum 3.00%, (FM 1-T 011)
Dry loose weight (AASHTO T 19)*	
Los Angeles Abrasion (FM 1-T 096)	
Ferric Oxide (ASTM C 641)	maximum 1.5 mg

*Source shall maintain dry-loose unit weight within $\pm 6\%$ of Quality Control average. Point of use dryloose unit weight shall be within $\pm 10\%$ of Source Quality Control average.

4.2 LIGHTWEIGHT COARSE AGGREGATE FOR STRUCTURAL CONCRETE

A. The requirements of 901-4.1 are modified as follows:

Aggregates shall not be produced from pumice and scoria. Los Angeles Abrasion (FM 1-T 096, Section 12) shall be 45%, maximum. Gradation shall meet the requirements of AASHTO M 195 for 3/4 inch, 1/2 inch and 3/8 inch.

PART 5 - RECLAIMED PORTLAND CEMENT CONCRETE

JFL	32 11 23- 7
St Croix	AGGREGATE BASE COURSES
5.1	The reclaimed Portland cement concrete shall be from a source which was produced and placed in accordance with applicable Specifications. The material shall be crushed and processed to provide a clean, hard, durable aggregate having a uniform gradation free from adherent coatings, metals, organic matter, base material, joint fillers, and bituminous materials.
5.2	The Contractor's (Producer's) crushing operation shall produce an aggregate meeting the applicable gradation requirements. The physical property requirements of 901-1.3 for Soundness shall not apply and the maximum loss as determined by the Los Angeles Abrasion (FM 1-T 096) is changed to 50.

5.3 The sources of reclaimed Portland cement concrete will be treated as a mine and subject to the requirements of Section 6 and Section 105.

PART 6 - EXCEPTIONS, ADDITIONS AND RESTRICTIONS

6.1 Pertinent specification modifications, based on material usage, will be found in other Sections of the specifications.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, apply to work of this Section.

1.2 DESCRIPTION

- A. Stabilize the designated portions of the pavement subgrade in both cut and fill sections to provide a firm and unyielding subgrade to the uniformity, density, bearing value, lines, grades and thicknesses herein specified or shown in the Drawings. The work includes mixing, compacting and grading for a complete job.
- B. Related Work Specified Elsewhere
 - 1. Asphalt Concrete Pavement Section 321130

PART 2 - MATERIALS

- 2.1 Local Materials: High bearing-soils or sand clay material. The materials passing the #40 mesh sieve shall have a liquid limit not greater than 30, and a plasticity index not greater than 10. Blending materials to meet these requirements will not be permitted unless authorized by the Engineer. When so permitted, the blended material shall be tested and approved before spreading.
- 2.3 Crushed Shell: Mollusk shell, but not steamed shell, (i.e., oysters, mussels, clams, cemented coquina, etc.). Gradation shall be such that at least 97% by weight of the total material passes a 1" sieve, and at least 50% by weight is retained on the #4 sieve. Not more than 20% by weight of the total material shall pass (by washing) the #200 sieve.

PART 3 - EXECUTION

- 3.1 Compaction: Compact the stabilized subgrade in both cuts and fills to a minimum density of 95% of maximum (AASHTO T-180) density. The subgrade shall be shaped to within 1/4 inch of the grades shown in the Drawings.
- 3.2 Maintenance: After the subgrade has been prepared as specified, Contractor shall maintain it free from ruts, depressions and all damage resulting from hauling or handling of any materials, equipment, tools, etc. All work which may become necessary in order to recompact the subgrade shall be at contractor's expense.
- 3.3 Testing: Provide density and bearing value tests at intervals not to exceed 250 feet for roadways or 10,000 square feet for parking areas.

END OF SECTION 321130

JFL – THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Harris Civil Engineers Project No. 07287000 SUBGRADE STABILIZATION Section 32 11 30- 1

1.1 GENERAL

1.1 SUMMARY

- A. Section includes all work required to complete, as indicated by the Contract Documents, and furnish all supplementary items necessary for the proper installation of the asphalt concrete paving, as required for the completion of the Work and/or restoration of existing asphalt pavement.
- B. Asphalt concrete paving, includes:
 - 1. Subgrade preparation.
 - 2. Aggregate base.
 - 3. Tack coat.
 - 4. Asphaltic concrete leveling course.
 - 5. Asphaltic concrete surface course.

1.2 DEFINITIONS:

A. Defective asphaltic paving: Consider defective any portion of the asphalt paving in which creeping, shoving, cracking, raveling, softening or other defects occur during Warranty period. Patch or replace as specified, and as approved by Owner.

1.3 QUALITY ASSURANCE

A. Reference Specifications and Standards:

1. FDOT (FLORIDA DEPARTMENT OF TRANSPORTATION): Standard Specifications for Road and Bridge Construction.

- B. Tests and inspections:
 - 1. Provide inspecting and monitoring for work specified under Article, "Field Quality Control".
 - 2. In addition to tests and requirements of FDOT, (FDOT- 200-7) conduct a water floods test of critical areas as directed.
 - 3. Completed surfaces: Free of standing water when flood tested. Remove and replace to proper grade with materials in compliance with Specifications.

1.4 SUBMITTALS

- A. Procedures: In accord with Division I.
- B. After award of contract and prior to start of work submit job mix formula, and hot-mix design data sheet, for each type mix used.

1.5 PRODUCT HANDLING

JFL – THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

Project No. 07287000 ASPHALT CONCRETE PAVING Section 32 12 16 - 1

A. Procedures: In accord with FDOT (FLORIDA DEPARTMENT OF TRANSPORTATION) Specifications.

1.6 SITE CONDITIONS

- A. Weather limitations:
 - 1. Apply bituminous prime coat only when the ambient temperature is 50°F. and rising and when the temperature has not been below 35°F. for 12 hours immediately prior to application.
 - 2. Do not apply when the base surface is wet or contains an excess of moisture which would prevent uniform distribution and the required penetration.
 - 3. Base course may be placed when air temperature is not below 30°F.
 - 4. Construct asphalt concrete surface course only in dry weather when temperature is above 40°F.
- B. Grade control: Establish and maintain the required lines and grades, including crown and crossslope, for each course during construction operations.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Asphalt concrete: Type SP-12.5 or as noted on Drawings. Conform to <u>2014 edition of the</u> FDOT <u>Specifications</u> Section 331.
 - 1. Provide plant mixed asphalt concrete in accord with methods and operations requirements of FDOT Sections 320 and 330-1 to 330-6.
- B. Prime coat: Cut-back asphalt, grade RC-70, conforming to FDOT Specifications Section 300.
- C. Tack coat: Asphalt emulsion (SS-1H) or (RS-2) grade conforming to FDOT <u>Specifications</u> Section 300.
- D. Seal coat: Seal coat is not required.

PART 3 - EXECUTION

3.1 INSPECTION AND PREPARATION

- A. Examine all surfaces over which asphalt is to be applied.
 - 1. Insure that no defects, low sections, depressions or holes are present which would jeopardize the standard of finish specified.

JFL – THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 07287000 ASPHALT CONCRETE PAVING Section 32 12 16 - 2 B. Proof roll subgrade using heavy, rubber-tired rollers. Check for unstable areas. Check for areas requiring additional compaction or replacement.

3.2 STABILIZATION OF SUBGRADE

A. Areas designated to be paved or to be restored to their preconstruction condition and having a soil-cement base shall be stabilized as indicated on the drawings to the depth shown from the grades indicated in accord with FDOT Standard Specification Section 160.

3.3 AGGREGATE BASE COURSE

- A. Minimum compacted thickness: 8 inch or as indicated on Drawings.
- B. Spread soil-cement in accordance with FDOT Standard Specifications Sections 200-4, 200-5.1 and 200-5.2.
- C. Compaction of soil-cement shall be accomplished in conformance with Section 200-6 of the FDOT Standard Specifications.

3.4 PRIMING AND MAINTAINING

- A. Priming: The prime coat shall be applied only when the base meets the specified density requirements and the moisture content in the top half of the base does not exceed 90 percent of the optimum moisture of the base material. At the time of priming, the base shall be firm, unyielding and in such condition that no undue distortion will occur.
- B. Maintaining: The Contractor will be responsible for assuring that the true crown and templet are maintained, with no rutting or other distortion, and that the base meets all the requirements, at the time the surface course is applied.

3.5 TACK COAT

- A. When new asphalt is to be placed against existing or new concrete or asphalt surfaces, such as curbs, gutters, walls, structures, or other paving, coat such surfaces with a tack coat of asphaltic emulsion before the new paving is placed.
- B. Apply tack coat by fogging method; no exceptions allowed.

3.6 ASPHALT CONCRETE

- A. Provide transportation, placing and compacting of asphalt concrete, preparation of application surfaces, joints, tolerances and protection of the finished asphalt in accord with FDOT Section 330.
 - 1. Refer to Division I for testing.
- B. Spread asphaltic concrete from a slow moving spreading machine to assure that mix is properly tamped.

JFL – THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 07287000 ASPHALT CONCRETE PAVING Section 32 12 16 - 3

- 1. Roll asphaltic concrete surface source with single pass while material is over 185°F.
- C. Spread asphaltic concrete in such a manner as to assure that transverse joints created by stopping and restarting paving equipment will be smooth and cause no objectionable visual defects or perceptible interruption that would be detected in a normal ride over the surface.

3.7 PATCHING

- A. Remove and replace defective areas.
- B. Cut-out and fill with fresh, hot asphalt concrete.
- C. Compact by rolling to specified surface density and smoothness.
- D. Remove deficient areas for full depth of course.
- E. Cut sides perpendicular and parallel to direction of traffic with edges vertical.
- F. Apply tack coat to exposed surfaces before placing new asphalt concrete mixture.

3.8 FIELD QUALITY CONTROL

- A. Receive approval from Engineer, prior to starting of Work, of all paving equipment:
 - 1. Paving equipment to be in accord with submittals furnished.
 - 2. Correct all deficiencies in equipment not meeting manufacturer's specifications prior to starting Work.
- B. Provide Engineer with certified evidence, prior to starting work, that source of material, job mix formula, and hot mix design is in accord with submittals furnished.
- C. Verify that all paving equipment is cleaned, in accord with equipment manufacturer's recommendations, at the end of each days paving operations.
- D. Material testing engineer or technician to visually observe and monitor placement and construction of soil-cement base material. Surface of the soil-cement shall be tested per FDOT Standard Specification Section 200-7.
 - 1. Verify that depth of base course meets or exceeds Work specifications.
- E. Material testing engineer to perform the following:
 - 1. Visual observations of uniformity and moisture condition of base material at arrival on site.
 - 2. Random depth checks both before and after final compaction to assure minimum compacted thickness as shown on the Drawings.
 - 3. Field density tests to assure uniform and satisfactory compaction in excess of 98% Maximum Density Value.

JFL – THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Harris Civil Engineers Project No. 07287000 ASPHALT CONCRETE PAVING Section 32 12 16 - 4

3.9 CLEANING AND PROTECTION

- A. Cleaning: After completion of paving operations, clean surfaces of excess or spilled asphalt materials. The cleaning process used may include sand blasting or other methods at the direction of the Owner. This work shall be at no additional cost to the Owner.
- B. Protection: After final rolling, do not permit vehicular traffic on asphalt concrete pavement until it has cooled and hardened, and in no case sooner than as permitted by FDOT Section 330.

END OF SECTION 321216

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes all work required to complete, as indicated by the Contract Documents, and furnish all supplementary items necessary for the proper installation of the site concrete.
- B. Site concrete work includes:
 - 1. Subgrade preparation.
 - 2. Concrete pavement, equipment pads and housing pads.
 - 3. Meandering concrete footpath, walkways and joints
 - 4. Concrete curbs and, gutters
 - 5. Light pole bases, complete with anchor bolts, leveling nuts and grout
 - 6. Reinforcing steel.
 - 7. Concrete work associated with Site and street furnishings
 - 8. Concrete utilities structures (catch basins, manholes, Inlet structures, junction Boxes, switching stations and similar.), and grout base /fillets.
 - 9. Post footings (concrete only), for Fences, Signage and miscellaneous items (thrust blocks, isolated pipe supports etc.)
 - 10. Built-in bolts, anchors, frames and all other embedments.

1.2 QUALITY ASSURANCE

- A Reference Specifications and Standards:
 - ACI: 305 Hot Weather Concreting.
 - ACI: 306 Recommended Practice for Cold Weather Concreting.
- B Allowable tolerances: 1/8 inch in 10 feet in any direction.
- C. Site mock-ups
 - 1. Provide for approval, a 4 feet x 4 feet x 4 inches thick minimum job site cast and finished sample panel for each type concrete finish. Cure samples as specified.
 - a. Include in each panel, all joint types which will occur in each type finish work.
 - 2. Cast samples on grade at locations as directed by Owner/Engineer.
 - 3. If first samples are not approved, prepare additional samples until approval is obtained.
 - 4. Sample panels will be used to judge final finish work.
 - 5. Protect samples during course of work, remove then when directed to do so by Owner/Engineer.
- D. Provide concrete test cylinders. Monitor slump and 28 day compressive strength. Samples to be taken at a rate of one per four cubic yards of concrete.

1.3 SITE CONDITIONS

JFL – THS 5 ACRE LEASE SITE Procurement Package 07/21/2023 Project No. 07287000 CURBS, GUTTERS, SIDEWALKS, AND DRIVEWAYS Section 32 16 00- 1

- A. Weather limitations:
 - 1. Do not place concrete when the atmospheric temperature is as low as 35°F or expected to go below that temperature within 24 hours.
 - 2. Do not place concrete during any rain that will cause surface damage to the concrete.
 - 3. Hot weather concreting: In accordance with ACI 305.
 - 4. Cold weather concreting: In accordance with ACI 306.
- B. Traffic control:
 - 1. Maintain vehicular and pedestrian traffic control during concrete operations.
 - 2. Provide flagmen, barricades, warning signs, and warning lights for movement of traffic and safety, and to cause the least interruption of work.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Concrete: Minimum acceptable Concrete Compressive Strength shall be as indicated on the Drawing.
- B. Formwork and finishing: Shall be in accordance with local building code regulations
- C. Reinforcement: Shall be in accordance with local building code regulations: Reinforcing Steel.
- D. Joint materials:
 - 1. Expansion joint filler: In accordance with FDOT Specifications Section 932-1.1, Preformed Joint Filler for Pavement and Structures.
 - 2. Expansion joint sealant: In accordance with FDOT Specifications Section 932-1.2, Joint Sealer for Pavement and Structures.
- E. Liquid bonding agent:
 - 1. Weld-crete by Larsen Products Corp.
 - 2. Lambco Latex 460 by Lambert Corp.
 - 3. Hornweld, by A.C. Horn, Inc.
 - 4. Sonocrete, by Sonneborn Building Products.
- F. Curing and protection paper: Sisalkraft Orange Label, by Sisalkraft Division, St. Regis Paper Co., or equivalent which complies with ASTM C171.
 - 1. Where concrete will be exposed and be subjected to abrasion, such as floor slabs, use nonstaining paper equivalent to Sisalkraft "Seekure 896", or other reinforced paper faced with polyethylene film.

JFL – THS 5 ACRE LEASE SITE Procurement Package 07/21/2023 Project No. 07287000 CURBS, GUTTERS, SIDEWALKS, AND DRIVEWAYS Section 32 16 00- 2

- G. Liquid Curing agents:
 - 1. Curing compound:
 - a. West Chemical Floor Treatment by West Chemical Products, Inc.
 - b. Horncure 30C by A.C. Horn, Inc.
 - c. Hunt Process TLF by Hunt Process Co., Inc.
 - d. Lambco 64B by Lambert Corp.
 - e. Hydrocide Curing Compound by Sonneborn Building Products.
 - 2. Combination curing and hardening compound.
 - a. Ashford Formula by U.S. Permaseal Inc.
 - b. West Chemical Floor Treatment by West Chemical Products, Inc.
 - c. Horn Clean Seal by A.C. Horn, Inc.
 - d. Sika Cure/Hard by Sika Chemical Co.
 - e. Crystal Clear Seal (interior) Crystal Gard Seal (Exterior by Lambert Corp.
 - f. Kure-N-Seal by Sonneborn Building Products.
 - 3. Chemical for hardener fluosilicate type delayed application:
 - a. Ashford Formula by U.S. Permaseal Inc.
 - b. Lapidolith by Sonneborn, Division of Contech, Inc.
 - c. Saniseal by Master Builders Co.
 - d. Permalith by L.M. Scofield Co.
 - e. Solidus by Lambert Corp.
 - f. Hornolith by A.C. Horn, Inc.
- H. Slip resistant abrasive aggregate: Aluminum oxide, 14/36 grading, manufactured by:
 - 1. Carborundum Company.
 - 2. Norton Company.
 - 3. A-H Products, Division of Anti-Hydro Waterproofing Company.
 - 4. L.M. Scofield Company.
 - 5. Burke Concrete Accessories, Inc.
- I. Integral mineral coloring pigments:
 - 1. L.M. Scofield Company, "Chromix".
 - 2. Davis, Colors.
 - 3. Lambert Corporation, Colors.
 - 4. Landers Segal Color Company, Inc.
- J. Curing materials for non colored concrete: In accord with FDOT Specifications Section 925, Curing Materials for Concrete.

- K. Borrow material (for fill): Clean earth and granular material free of roots and organic materials, not more than 10 percent passing a No. 200 sieve. No rocks or lumps larger than 6 inches in any dimension will be permitted.
- L. Extra Heavy-Duty, Processed Iron Aggregate Topping
 - 1. Anvil-Top 300" manufactured by Master Builders, processed size graded aggregate, (not a naturally occurring mineral aggregate), cement, and technical components, necessary to produce screedable, metallic floor topping. Manufacturer shall certify he has a minimum of 20 years' experience in manufacturing iron aggregate floor toppings, and can document success. Material shall be ready to use and require only addition of water at jobsite, shall be sealed in moisture resistant 55 lbs. (25kg) bags, or 3,300 lb. (1497 kg) bulk bags. Material shall be formulated and processed under stringent quality control, free from non-ferrous particles rust and material intended to disguise rust.
 - 2. Material shall be applied at the rate of 18.0 lb/sq. ft. (87.8 kg./m2) for specified 1" thickness (25mm), in accordance with the manufacturer's installation instruction applied over concrete properly roughened and bonded or over fresh, plastic concrete. (Under no circumstances should less than a 1/2" (13mm) thickness be used).
 - 3. Curing Material for topping shall be "Masterseal W," manufactured by Master Builders, shall exceed moisture retention requirements of ASTM-C 309-81, when used at a rate of coverage recommended by the manufacturer.

PART 3 - EXECUTION

3.1 PREPARATION OF SUBGRADE

- A. Compaction: Compact top 12 inches subgrade to 95% maximum density in accordance with ASTM D3017 (Nuclear method), or ASTM D1557 Method A (5-layer method).
- B. Do not allow traffic over prepared subgrade.
- C. Uniformly moisten subgrade at time concrete is placed. Uniformly apply water ahead of concrete placement.
- D. Accurately trim to required elevations.
- E. Allow for full thickness concrete.

3.2 SITE STRUCTURES

A. Construct catch basins, manhole bases, junction boxes, inlets, and other similar site structures to conform to requirements of FDOT SPECIFICATIONS Section 425, Inlets, Manholes and Junction Boxes.

3.3 JOINTS

JFL – THS 5 ACRE LEASE SITE Procurement Package 07/21/2023 Project No. 07287000 CURBS, GUTTERS, SIDEWALKS, AND DRIVEWAYS Section 32 16 00- 4

- A. Pour joints:
 - 1. Construct pour joints (construction joints) at any break in concrete placement lasting more than 1 hour.
 - 2. Construct pour joints as indicated at color changes.
 - 3. Except at expansion joints, key pour joints.
- B. Expansion joints:
 - 1. Construct expansion joints at locations indicated.
 - 2. Seal expansion joints with sealer as specified.
- C. Control joints:
 - 1. Construct control joints (contraction joints) at locations indicated.
 - 2. Pour joints may be substituted for control joints at Contractor's option.

3.4 CURING FORMED SURFACES

- A. Commence curing formed concrete surfaces with water as quickly as formwork is loosened or removed.
- B. Thoroughly saturate concrete surfaces and maintain them uniformly wet for a period of not less than 14 days after concrete has been placed.
 - 1. During the curing period, soak the surfaces as often as necessary to maintain thoroughly saturated condition.
 - 2. It is mandatory that water curing be continued as a case of emergency during holidays and weekends.

3.5 FINISHING FORMED SURFACES

- A. Finish all surfaces of formed concrete which will remain exposed in the finish work, both interior and exterior, including surfaces which will be painted. Provide surfaces uniform for the intended texture; free from imperfect joints, fins, "honeycombing", air pockets or "bug" holes, or other such imperfections.
- B. Remove rough spots, stains and hardened mortar or grout from intended smooth surfaces by rubbing such surfaces lightly with fine carborundum stone. Use liberal amounts of water and rub sufficiently to remove defects without changing texture of concrete.
- C. If intended smooth surfaces are not of uniform texture, treat as follows.
 - 1. Prepare a mix consisting of one-part portland cement, 1-1/2 parts fine sand, and sufficient water to produce a grout of the consistency of thick paint.
 - 2. Wet surface to be treated and apply grout uniformly with a brush, completely filling air holes. Immediately float, scouring the surface vigorously. Allow cement grout to partially set for an hour or two depending on weather.

JFL – THS 5 ACRE LEASE SITE Procurement Package 07/21/2023 Project No. 07287000 CURBS, GUTTERS, SIDEWALKS, AND DRIVEWAYS Section 32 16 00- 5

- 3. When grout has sufficiently hardened so it can be scraped from surface with the edge of a steel trowel without removing grout from small air holes, cut-off all that can be removed with a trowel, allow surface to dry thoroughly, then rub vigorously with burlap to completely remove surplus.
- 4. Further finish exposed intended smooth surfaces, if necessary, by means of honing with a carborundum stone to uniform surfaces as directed by Owner.
- 5. Complete entire operation of any area the day it is started.
- 6. Do not use dry cement sacking.

3.6 FINISHING AND CURING FLAT WORK

- A. Finishing:
 - 1. Tamp freshly placed concrete with approved metal grid tampers not less than 12 inches x 12 inches in size so as to bring fines to top, then rod to uniform surfaces at required levels.
 - a. Float and trowel finish as soon as surface becomes workable.
 - b. Provide slopes as indicated on Drawings, or as directed by Owner.
 - 2. Provide fog-spray equipment for use during finishing to maintain adequate surface moisture and reduce plastic shrinkage.
 - a. Immediately after fresh concrete has been brought to a flat surface, a shiny film of moisture will appear on top. As soon as the shiny surface disappears, it must be restored and maintained until troweling, by providing a light film of moisture with an atomizing type fog-sprayer.
 - b. Use frequent light applications of moisture rather than excessive wetting. Temperature, humidity and wind conditions will dictate the amount of spray required for proper control.
 - 3. Work and measure concrete flatwork until it is level to within 1/8 inch in 10 feet in any direction.
- B. Surface finish textures:
 - 1. Brush or broom finish: Use for inclined ramps, and all other exterior locations.
 - a. Apply color pigment uniformly and at a rate to achieve the color selected and approved by Owner. Apply in accordance with pigment manufacturer's instructions.
 - b. Apply sealer over finished surfaces in accordance with manufacturer's instructions.
 - c. The brush or broom finish is achieved by drawing a push broom across the still plastic surface to create uniform striations.
 - d. In some instances, if directed by Owner, striations may be zig-zag type.
 - e. In some instances, if directed by Owner, create texture striations by use of a stiff fiber bristle broom.
- C. Curing:

JFL – THS 5 ACRE LEASE SITE Procurement Package 07/21/2023 Project No. 07287000 CURBS, GUTTERS, SIDEWALKS, AND DRIVEWAYS Section 32 16 00- 6

- 1. Cure flat slabs with combination curing and hardening compounds.
 - a. Apply compound in accordance with manufacturer's recommendations immediately following final finishing operations.
- 2. Cure all concrete not otherwise specified, with liquid curing compound.
 - a. Caution: Some waterproofing materials are not compatible with some curing compounds. Verify compatibility of materials before curing concrete slabs which will receive direct applied waterproofing.

3.7 EXTRA HEAVY-DUTY TOPPING

- A. Application of Extra Heavy-Duty, Iron Aggregate Topping
 - 1. Manufacturer's representative shall be present during initial stages of installation. Installer shall consult with manufacturer's representative during bidding and prior to installation on correct use of the product. Deviation from the manufacturer's recommendations will be responsible of the installer.

Minimum Slump	-	not less than 5" (127 mm).
Maximum Slump	-	not to exceed 7" (178 mm).

- B. Surface Preparation: Mixing and Placing of Topping
 - 1. Preparation of base concrete, mixing of materials and application of the topping shall be in strict accordance with manufacturer' procedures, as indicated in current product data and direction sheets and/or as described by manufacturer's rep. DO NOT OVER FINISH.
- C. Curing and Protection
 - 1. WET CURE FOR MIN. OF 48 HOURS, PRIOR TO APPLYING CURING COMPOUND.
 - 2. Concrete finished with Anvil-Top 300, processed iron aggregate topping, shall be cured with Masterseal W, in accordance with manufacturer's recommendations. Manufacturer of the iron aggregate topping shall provide, at no cost, services of a trained, full-time employee, during periods of critical installation. A minimum of three (3) days' notice shall be given by the contractor, to the manufacturer, prior to initial use of the product.

END OF SECTION 034701

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract apply to work of this Section 321216.

1.2 DESCRIPTION OF WORK

- A. Pavement markings.
 - 1. Provide marking paint for perimeter and marking outside traffic flow patterns or in areas where existing markings have been disturbed.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Asphalt concrete paving - Section 321216

1.4 SUBMITTALS

- A. Procedure: Submit in accord with General Conditions.
- B. Product data: Submit manufacturer's detailed literature.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Pavement Marking Paint
 - 1. Conform to the requirements of FDOT Specifications Section 971.
 - 2. Color
 - 3. White Code T1
 - 4. Yellow Code T2
 - 5. Acceptable
 - a. Tnemec's Traffic Paint
 - b. Glidden-Durkee's Romark Traffic
 - c. PPG's Traffic and Zone Marking
- B. Thermoplastic Compound
 - 1. Conform to the requirements of FDOT Specifications Section 711

PART 3 - EXECUTION

3.1 PAINT MARKINGS APPLICATION

JFL – THS 5 ACRE LEASE STE Procurement Package 07/21/2023

- A. Obtain approval of marking layouts prior to paint application.
- B. Traffic line markings: 4 inches wide unless otherwise indicated.
- C. Machine apply in strict accord with recommendations of paint manufacturer.
- D. Apply two coats or more as required for complete opacity.
 - 1. Apply first coat after all paved surfaces to be painted are dry and cured for a minimum of 48 hours.
 - 2. Apply second or final coat prior to completion of project.
- E. Paint directional lettering, arrows and other markings by similar methods with same paint. Use stencils and masking tape as required to achieve required designs.

END OF SECTION 321723

PART 1 - GENERAL

1.1 WORK INCLUDED

A. The Work included in this section shall pertain to the identification of potable water, industrial water, chilled water supply/return and gas buried piping in the site. The work shall include but not be limited to the installation of identification/warning tape, copper tracing wire, and color coding on pipe.

PART 2 - PRODUCTS

2.1 IDENTIFICATION/WARNING TAPE

- A. All utility piping shall be installed with 3 inch wide metallic or vinyl continuous tape, for identification and warning purposes, buried directly above the centerline of the pie at a maximum depth of 18 inches or as approved by the Work's engineer of record.
- B. The identification/warning tape shall be colored and labeled as follows:
 - 1. Potable Water Main Tape.
 - a. Color: Blue with Black Lettering
 - b. Lettering: "CAUTION: WATER LINE BURIED BELOW" or similar wording.
 - 2. Reuse Water Main Tape.
 - a. Color: Purple with Black Letteringb. Lettering: "CAUTION: REUSE WATER LINE BURIED BELOW" or

similar wording.

- 3. Brine Water Main Tape.
 - a. Color: Orange with Black Lettering
 - b. Lettering: "CAUTION: BRINE WATER LINE BURIED BELOW" or similar wording.
- 4. Gas Main Tape.
 - a Color: Yellow with Black Lettering
 - b Lettering: "CAUTION: GAS MAIN BURIED BELOW" or similar wording.
- 5. Raw Water Main Tape.
 - a Color: Green with Black Lettering
 - b Lettering: "CAUTION: RAW WATER MAIN BURIED BELOW" or similar wording.
- 6. Sewer Main Tape.
 - a Color: Brown with White Lettering
 - b Lettering: "CAUTION: SEWER MAIN BURIED BELOW" or similar wording.

JFL -THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

Harris Civil Engineers

Project No. 07287000 PIPE IDENTIFICATION Section 33 05 26 - 1

- 7. Force Main Tape.
 - a Color: Brown with White Lettering
 - b Lettering: "CAUTION: FORCE MAIN BURIED BELOW" or similar wording.
- C. All lettering shall appear legibly on the tape and shall run the entire length of the pipe.

2.2 COPPER INDENTIFICATION WIRE

A. All non-metallic pipe shall be installed with a continuous, insulated 14 gauge copper wire installed directly on top of the centerline of the pipe for location piping.

2.3 **PIPE COLOR IDENTIFICATION**

A. All potable water, industrial water, chilled water and gas main utility piping shall be marked with a continuous minimum 2" paint stripe located at the 12'o clock position or the pipe shall be a solid color as follows:

1.	Potable Water Line Stripe or Pipe Color:	Blue
2.	Reuse Line Stripe or Pipe Color:	Purple
3.	Brine Water Line Stripe or Pipe Color:	Orange
4.	Gas Main Stripe or Pipe Color:	Yellow
5.	Raw Water Main Stripe or Pipe Color:	Green
6.	Force Main Stripe or Pipe Color:	Brown
7.	Sewer Water Main Stripe or Pipe Color:	Brown

B. Backfill shall not be placed for 30 minutes following paint application.

PART 3 - EXECUTION

3.1 PIPE WRAPPING

- A. All reinforced concrete pipes and corrugated high density polyethylene pipes must be wrapped securely to ensure the joints are not exposed to the elements.
- B. There must be no dirt allowed in the system or the wrapping.

END OF SECTION 330526

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. This Section shall include, but not be limited to, all labor, equipment, tools, materials and all incidentals required for the construction, installation, testing and disinfection of a potable and reuse water distribution systems, including all appurtenances as shown on the Drawings and as specified herein. All references to and requirements for "potable water" or "water" systems contained in this section shall also apply to the industrial water system.
- B. The work shall include but not be limited to, ductile iron pipe, PVC pipe, high density polyethylene (HDPE) pipe, valves, air release and vacuum valves, pressure reducing or sustaining valves, ductile iron fittings, strainers, tapping tees and sleeves, tapping saddles, cast iron valve boxes, backflow preventers, master meters, valve vaults and boxes, all restrained joints as required for all types of piping, all excavation, sheeting, shoring and bracing, dewatering, jacking and boring, where required, slope protection, backfilling, grading and drainage, concrete work, rip-rap, compaction, grass restoration, pavement restoration, where required, and all other work necessary to complete the construction, installation, testing and disinfection of the potable water distribution system.

1.2 RELATED SECTIONS

- A. Soils Report and Other Information
- B. Shop Drawings, Product Data and Samples
- C. Site Preparation
- D. Excavating and Backfilling for Utilities

1.3 QUALITY ASSURANCE

A. Reference Standards:

DIPRA Handbook of Ductile Iron Pipe. Uni-Bell Handbook of PVC Pipe. Recommended Standards for Water Works, (Ten-State Standards) Florida Department of Environmental Protection, F.A.C. 62-500. Canadian International Standard (ISO)

- B. Reference Specifications:
 - 1. This standard references the following documents, which forms a part of this standard to the extent specified herein. In any case of conflict, the most restrictive standard shall prevail. For all reference specifications, the latest edition shall apply.
 - a. ASTM D746 (ANSI/AWWA C151/21.51) Ductile Iron Pipe.
 - b. ASTM A536 (ANSI/AWWA C153/A21.53) Compact Ductile Iron Fittings.
 - c. (ANSI/AWWA C110/A21.10) Ductile Iron Fittings, 3 inches through 48 inches, for Water and Other Liquids.

JFL – THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 07287000 POTABLE & REUSE WATER DISTRIBUTION SYSTEMS Section 33 11 10 - 1

- d. (ANSI/AWWA C104/A21.4) Cement Mortar Lining For Ductile Iron Pipe and Fittings For Water.
- e. (ANSI/AWWA C111/A21.11) Rubber Gasket Joints For Ductile Iron Pipe and Fittings.
- f. AWWA C600, Installation of Ductile Iron Water Mains and Appurtenances.
- g. ANSI/AWWA C105/A21.5, Polyethylene Encasement For Ductile Iron Piping For Water and Other Liquids.
- h. ASTM D1784, Rigid Poly Vinyl Chloride (PVC) Compounds and Chlorinated Poly Vinyl Chloride (CPVC) Compounds.
- i. ASTM D2241 (AWWA C900), Standard Specification for Poly Vinyl Chloride (PVC) Plastic Pipe.
- j. ASTM F477, Elastomeric Seals for Joining Plastic Pipes.
- k. ASTM D3139, Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
- 1. ANSI/AWWA C500, Standard For Gate Valves For Water and Sewage Systems.
- m. ANSI/AWWA C509, Standard For Resilient Seated Gate Valves For Water and Sewage Systems.
- n. ANSI/AWWA C504, Standard For Rubber-Seated Butterfly Valves.
- o. AWWA C503, Standard For Wet Barrel Fire Hydrants.
- p. AWWA C906-90, Polyethylene Pipe and Fittings for Water Distribution
- q. ASTM C478, Precast Concrete Valve Boxes and Vaults.
- r. ASTM C94, Concrete, Type II.

C. INSPECTION AND CERTIFICATION OF PIPE AND FITTINGS:

- 1. All pipe fittings and appurtenances to be installed under this Section may be inspected and tested for compliance with these Specifications at the manufacturer's facility by an independent testing laboratory selected by the Contractor. The manufacturers' cooperation shall be required in these inspections.
- 2. The Contractor shall obtain from the pipe manufacturer a certificate of inspection stating that the pipe and fittings supplied for this Work has been inspected and tested at the point of origin, and that they meet or exceed the requirements set forth in these Specifications.
- 3. The costs of the inspections and tests shall be borne by the Contractor. Letters of certification shall be furnished for all inspections and tests prior to the installation of the pipe, fittings and appurtenances.

E. INSPECTION UPON DELIVERY:

- 1. All pipe fittings and appurtenances shall be subject to visual inspection at the point of delivery and again just before being lowered into the trench. All materials found to be defective due to manufacture, or damaged in transit shall be rejected and shall be immediately removed by the Contractor from the job site.
- 2. The Owner or the Utility may perform or cause to be performed all tests as specified in the applicable AWWA Standards, to ensure conformance with the standard. In the case of failure of the pipe or appurtenances to comply with such standards, the responsibility for replacement of the defective materials becomes that of the Contractor.
- 3. The entire product of any manufacturer may be rejected when, in the opinion of the Design Engineer or the Utility Owner, the methods of manufacture fail to secure uniform

JFL – THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 07287000 POTABLE & REUSE WATER DISTRIBUTION SYSTEMS Section 33 11 10 - 2

results, or where the materials are such as to produce pipe and/or fittings of inferior quality.

1.4 EXPERIENCE

A. The Contractor shall be a firm with not less than five (5) years of successful experience in the installation and construction of pipelines incorporating products and materials similar to those specified herein.

1.5 HANDLING AND STORAGE OF PIPE FITTINGS AND APPURTENANCES

- A. All pipe, fittings and appurtenances shall be loaded and unloaded by lifting with hoists or skidding in order to avoid shock or damage.
 - 1. Pipe, fittings and appurtenances shall not be dropped, rolled or skidded into or against pipe, fittings or other construction products on the ground.
 - 2. Slings, hooks, pipe tongs and other lifting devices shall be padded and used in such a manner as to prevent damage to pipe or construction products.
 - 3. Stored materials shall be kept safe from damage. The interior of all pipe, fittings and appurtenances shall be kept free from dirt, oil, grease and foreign matter at all times.
- B. Pipe shall not be stacked higher than recommended by the manufacturer or the limits shown in the following table, whichever is most stringent.

MAX	IMUM	STACKI	NG HE	EIGHTS	FOR PI	PE				
NOM	INAL I	PIPE								
SIZE	(INCH	ES)	4	6	8	10	12	14	16	18
20	24	30	36	42						
NUM	IBER O	F TIERS	16	13	11	10	9	8	7	6
6	5	4	4	3						

The bottom tier shall be kept off of the ground on timbers. Pipe in tiers shall be alternated, i.e., bell, plain end; bell, plain end, etc. No less than two rows of timbers shall be placed between tiers. Chocks shall be affixed to each, in order to prevent movement. The timbers shall be large enough to prevent contact between pipe in adjacent tiers.

- C. The Contractor shall cover stored PVC and polyethylene pipe to prevent exposure to ultraviolet radiation.
- D. Pipe gaskets shall be used in the work on a first-in, first-out basis.
 - 1. Gaskets for mechanical joint and push-on joint ductile iron pipe and fittings shall be stored in a cool, dry location, out of direct sunlight.
 - 2. Gaskets shall be stored in such a manner so as to prevent coming into contact with petroleum products.
- E. Mechanical joint bolts and locking segments for push-on joints shall be handled and stored in such a manner that will ensure proper use with respect to pipe types and sizes.

JFL – THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 07287000 POTABLE & REUSE WATER DISTRIBUTION SYSTEMS Section 33 11 10 - 3

1.6 TESTING <u>AND INSPECTION</u>

A. Refer to Division I.

B. TEST METHODS AND INSPECTIONS:

- 1. Maximum density and optimum moisture content of soils in place and field density of soils in place shall conform to Section Excavation and Backfill for Utilities.
- 1. Hydrostatic pressure and leakage testing of potable water mains in accordance with AWWA C600, latest edition, and in accordance with Part 3.09 of this Section.
- 2. Disinfection and testing of potable water pipelines in accordance with AWWA C651, latest edition, AWWA Manual M12, and Part 3.10 of this Section.

1.7 REQUIREMENTS

- A. Unless indicated otherwise in the Drawings or as specified herein, the minimum cover for potable water mains shall not be less than 36 inches.
- B. Potable water mains shall be laid in the dry. All work occurring at trench depths below groundwater level shall be dewatered and maintained in a dry condition continuously while work is taking place at those elevations. All dewatering shall conform to the requirements of Section Dewatering.
- C. Where Ductile Iron Pipe are to be laid in or at the surface of brackish ground water the pipes shall be protected with polyethylene encasement in accordance with AWWA C105, from the adverse external aggressive soil and or ground water conditions.
- D. Potable water mains and appurtenances shall be constructed using the materials indicated on the Drawings and as specified herein, substitutions shall not be made without the expressed approval of the Engineer or Owner and the Utility.
- E. The Contractor shall not cover lines until they have been inspected and approved, and all required testing has been performed and passed.
- F. Conflict encasement shall be in accordance with the Drawings.
- G. Air relief manholes and air and vacuum relief valves shall be installed as indicated on the Drawings. Air relief manholes and valves shall be in accordance with 2.01 G. of this Section.

1.8 SUBMITTALS

- A. PROCEDURES:
 - 1. Submit product data, shop drawings, samples, testing laboratory reports, etc. in a timely manner and in accordance with the general requirements of Division I: Shop Drawings, Product Data and Samples.
- B. PRODUCT DATA:

JFL – THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 07287000 POTABLE & REUSE WATER DISTRIBUTION SYSTEMS Section 33 11 10 - 4

- 1. Submit manufacturer's detailed product literature, which shall include, where applicable, mill test reports, equipment capacity data, manufacturer's literature that notes compliance with the reference standards including, but not limited to, product type, pressure rating, schedule, class, grade, and all other information pertinent to the installation.
- 2. The data to be submitted shall include, but not be limited to:
 - a. Ductile iron pipe and fittings.
 - b. Polyvinyl chloride (PVC) pressure pipe.
 - c. Elastomeric seals for ductile iron and PVC pipe joints.
 - d. Polyethylene pipe and fittings.
 - e. Resilient seated gate valves.
 - f. Air and vacuum relief valves.
 - g. Tapping tees and tapping sleeves.
 - h. Cast iron valve boxes.
 - i. Precast concrete valve vaults.
 - j. Valve operators.
 - k. Mechanical joint retainer glands. (UL/FM)
 - 1. Corrosion protection materials.
 - m. Underground marker tape.
 - n. Underground tracer wire and appurtenances.
 - o. Fire hydrants and fittings.
 - p. Pressure reducing or sustaining valves.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

- A. Ductile iron pipe (DIP) and fittings for potable water service shall conform to ANSI/AWWA C151/A21.51.
 - 1. Ductile iron pipe shall have a minimum tensile strength of 60,000 p.s.i. with a minimum yield strength of 42,000 p.s.i.
 - 2. Pipe thickness shall be in accordance with Table 50.12, ANSI/AWWA C150/A21.50 and shall be Pressure Class 350.
 - 3. Ductile iron pipe for potable water main service shall have a cement mortar lining and a bituminous seal coat in accordance with ANSI/AWWA C104/A21.4 and a minimum 1.0 mil bituminous coating on the pipe exterior in accordance with ANSI 21.51.
 - 4. Unless specifically required by the Drawings, Ductile iron pipe shall be supplied in lengths not in excess of a nominal 20 feet, and unless otherwise specified, shall have mechanical joints conforming to Table 10.1 ANSI/AWWA C110/A21.10. Single gasket push-on joints on mechanical joints conforming to ANSI/AWWA A21.11/C111 shall be used on all ductile iron pipe except where restrained joints are required.
 - 5. High strength, low alloy mechanical joint T-bolts and nuts conforming to ANSI/AWWA C111/A21.11.
 - 6. Mechanical joint gaskets shall conform to ANSI/AWWA C111/A21.11, latest revision.
 - 7. Where called for on the Drawings, polyethylene encasement for ductile iron pipe shall conform to ANSI/AWWA C105/A21.5.

JFL – THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 07287000 POTABLE & REUSE WATER DISTRIBUTION SYSTEMS Section 33 11 10 - 5

- 8. Acceptable manufacturers:
 - a. U.S. Pipe.
 - b. American.
 - c. Clow.

B. COMPACT DUCTILE IRON FITTINGS:

- 1. Potable water distribution pipe fittings shall be ductile iron conforming to ANSI/AWWA C153/A21.53.
 - a. Rubber gasket joints shall conform to ANSI/AWWA C111/A21.11.
- C. FLANGED DUCTILE IRON PIPE AND FITTINGS WITH THREADED FLANGES:
 - 1. Flanged ductile iron pipe and fittings, where called for on the plans, shall conform to ANSI/AWWA C115/A21.15.
 - 2. Flanges shall be furnished flat faced and drilled to 125-pound template in accordance with B16.1 full-faced gaskets.
 - 3. Acceptable manufacturers:
 - a. U.S. Pipe.
 - b. American.
 - c. Clow.
- D. Polyvinyl chloride (PVC) pressure pipe and fittings for potable water service, in sizes 4-inch through 12-inch shall conform to AWWA C900, latest revision.
 - 1. Laying lengths shall be 20 feet ± 1 inch for all sizes.
 - 2. PVC pipe shall be Class 150 (SDR 18) with cast iron outside dimensions.
 - 3. PVC pipe joints shall have an integral wall-thickened bell end with gasket seal conforming to ASTM D3139. Solvent weld joints will not be permitted.
 - 4. All PVC pipe shall be identified on the exterior of the pipe with the following information:
 - a. Nominal pipe size and O.D. base.
 - b. Material code designation number.
 - c. Dimension ratio number.
 - d. AWWA pressure class.
 - e. AWWA designation.
 - f. Pipe manufacturers name and production code.
 - g. All PVC pipe shall be UL-FM approved.
 - 5. PVC pipe smaller than 4-inch in size shall be 200 psi, (SDR-14) in I.P.S. dimensions, manufactured from 1120 resin.
 - 6. Acceptable manufacturers:
 - a. Johns Manville.
 - b. Certainteed.
 - c. H&W.

JFL – THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 07287000 POTABLE & REUSE WATER DISTRIBUTION SYSTEMS Section 33 11 10 - 6

d. Clow.

- E. Polyethylene pipe pressure pipe and fittings for potable water service, in sizes 4-inch through 63inch shall conform to AWWA C906, latest revision.
 - 1. Polyethylene pipe shall have a minimum pressure rating of 150 psi.
 - 2. Size of pipes as shown on the plans refer to minimum inside diameter of pipes. Exceptions may be made on a case by case basis.
- F. Resilient seated wedge gate valves for potable water service shall conform or exceed all applicable requirements of AWWA C509.
 - 1. All resilient seated wedge gate valves shall have non-rising stems fitted with O-Ring seals for counter clockwise operation and a 2-inch square operating nut.
 - 2. All resilient seated wedge gate valves shall be bubble tight at 200 psi.
 - 3. Each valve shall have the manufacturer's name, pressure rating, the year of manufacture, and an arrow to indicate the direction of opening cast into the valve body.
 - 4. The interior of the valve body and bonnet shall have a factory applied 2-part thermo setting epoxy resin lining equal to Endurall 3300.
 - 5. Each valve shall be hydrostatically tested to a pressure equal to twice the specified working pressure prior to shipment from the factory. The manufacturer shall certify each valve.
 - 6. Acceptable manufacturers:
 - a. American Flow Control (Series 2500)
 - b. Or Approved Equal
- G. AIR RELEASE VALVES for potable water service shall be installed as shown on the Drawings. The valves shall be constructed with a cast iron body, cover and baffle, stainless steel float, bronze water diffuser, BUNA-N or viton seat and stainless steel trim.
 - 1. Valves shall be provided with a vacuum check to prevent air from re-entering the line. All fittings shall be threaded.
 - 2. Air release valves shall be Model 200 as manufactured by Apco Valve and Primer Corporation, Schaumburg, Illinois.
- H. CORPORATION STOPS: The use of direct tapping into pipe using corporation stops for water service connections will not be approved.
 - 1. All service taps shall be made using approved type service saddles.
 - 2. Service saddles shall not be less than 2 inches.
- I. SERVICE SADDLES OR TAPPING SLEEVES
 - 1. Size-on-size taps using tapping saddles or sleeves will not be permitted.
 - 2. Where size-on-size outlets are required, a tee shall be installed in lieu of a tapping saddle or sleeve. Tapping saddles and tapping sleeves will only be permitted on lines that are at least one nominal pipe size or diameter larger than the proposed tap.
 - 3. Tapping saddles and tapping sleeves shall be ductile iron and shall be epoxy, nylon or PE coated (min. 10 mils).

JFL – THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 07287000 POTABLE & REUSE WATER DISTRIBUTION SYSTEMS Section 33 11 10 - 7

- 4. Approved manufacturers:
 - a. Rockwell.
 - b. Mueller.
 - c. Ford.
 - d. Romac.
 - e. Cascade.
- 5. Tapping sleeves for use on pipe 14 inches and larger in diameter shall be ductile iron with mechanical joint.
- 6. Acceptable manufacturers:
 - a. Clow.
 - b. Mueller.
 - c. American.
 - d. Dresser.
- 7. Tapping sleeves for use on water mains 12-inches in diameter and smaller shall be fabricated of 18-8 stainless steel for corrosion resistance. The outlet of the tapping sleeve may be either extruded or welded to the tapping sleeve. All welds shall be fully passivated to restore the stainless steel quality and characteristics. The flange shall be stainless steel with a recess to accept standard tapping valves. The flange shall conform to AWWA C-207, Class D, ANSI 150 lb. drilling. Bolt holes shall straddle the pipe centerline.
- 8. The sleeve shall be equipped with a 3/4 inch NPT 18-8 stainless steel plug with a standard square head for testing. The gasket shall be of 360-degree design, and manufactured of gridded virgin GPR (Ground Penetrating (Probing) Radar) compounded for water service and complying with ASTM D-2000-80M 4AA607. An 18-10 stainless steel armor shall be vulcanized to the gasket, to bridge the gap between the securing lugs.
- 9. All bolts and nuts shall be 18-8 stainless steel with 5/8 inch NC threads. The lifter bar shall be of adequate design to provide a heavy bearing surface for all nuts. Bolt threads shall be fluorocarbon coated to prevent galling. Nylatron G.S. washers shall be provided for lubrication.

J. TAPPING VALVES

- 1. Valves for use with tapping sleeves shall meet or exceed all provisions of AWWA C509.
- 2. Valves for use with tapping sleeves shall be resilient seated wedge gate type and shall be designed for use with tapping equipment. The valves shall have non-rising stems and shall have an alignment ring to prevent misalignment with the tapping sleeves.
- 3. The valves shall close clockwise (right) and open counter clockwise (left), and shall be equipped with a standard 2-inch square operating nut. Valve outlets shall have a flanged by mechanical joint.
- K. PIPE RESTRAINT:
 - 1. Mechanical pipe restraining mechanisms for push-on or mechanical joints shall be used where indicated on the Drawings or as directed by the Engineer.
- 2. Restraining glands, tie rods, clamps or other components of dissimilar metals shall be protected against corrosion by the application of a suitable coating at the direction of the Engineer.
- 3. Mechanical restraints shall be sized for the working pressure plus surge allowance, or a test pressure of 200 psi, whichever is greater. Adequate factors of safety shall be employed.
- 4. Mechanical joint restraint shall be incorporated in the design of the follower gland and shall include a restraining mechanism which, when actuated, imparts multiple wedging action against the pipe, increasing its resistance as the pressure increases. Flexibility of the joint shall be maintained after burial. Glands shall be manufactured of ductile iron conforming to ASTM A 536. Restraining devices shall be of ductile iron heat treated to a minimum hardness of 370 BHN. Dimensions of the gland shall be such that it can be used with the standard mechanical joint bell and tee-head bolts conforming to ANSI A21.11 and ANSI/AWWA C 153/A21.53. Twist-off nuts shall be used to ensure proper actuating of the restraining devices.
- 5. The minimum number of restrained joints required for resisting forces at fittings and changes in direction of pipe shall be determined from the length of restrained pipe on each side of fittings and changes in direction necessary to develop adequate resisting friction with the soil.
- 6. As a minimum, ductile iron pipe joints shall be restrained each side of the fitting for a continuous distance as shown on the Drawings. The lengths shall be increased by 25 percent for pipe that is encased in polyethylene. Where conditions do not provide adequate soil friction, the required lengths may be increased.
- 7. Bolts and nuts for restrained joints shall be corten, low alloy, high strength steel conforming to AWWA standards.
- 8. Restrained glands shall be MegaLug or approved equal.
- L. VALVE BOXES:
 - 1. All buried valves shall have cast iron two- or three piece valve boxes with cast iron covers.
 - 2. Valve boxes shall be provided with suitable heavy bonnets and to extend to such elevation at or slightly above the finished grade surface. The barrel shall be one or two piece, screw type, having 5 ¹/₄ inch shaft.
 - 3. All valves shall have actuating nuts extended to within six inches of the top of the valve box cover.
 - 4. Valve boxes shall be provided with concrete bases.

M. FIRE HYDRANTS

- 1. Fire hydrants must be in accordance with AWWA C502.
- 2. Hydrants should have $2 2\frac{1}{2}$ " outlet nozzles and $1 4\frac{1}{2}$ ", pumper nozzle with standard hose threads. Caps must be provided on nozzles and attached by chains.
- 3. Hydrants should be installed with break-away flange at base
- 4. Two operating keys shall be provided with each hydrant installed.

PART 3 - EXECUTION

3.1 PIPELINE TRENCH CONSTRUCTION

JFL – THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 07287000 POTABLE & REUSE WATER DISTRIBUTION SYSTEMS Section 33 11 10 - 9

A. Refer to Section Excavating and Backfilling for Utilities.

3.2 SETTING VALVE VAULTS

- A. The soil foundation beneath the precast unit shall be stabilized and compacted to 95 percent of the maximum density as determined by ASTM D1557 and ASTM D1556.
 - 1. The precast valve vaults shall be carefully placed on the prepared foundation so as to be fully and uniformly supported in true alignment, making certain that the pipe can pass through on the designed line and grade.
 - 2. Precast valve vaults shall be handled by lifting rings only.
 - 3. Precast valve vaults and manholes shall be placed and aligned to provide vertical alignment with not more than 1/8 inch maximum tolerance for 5 feet of depth. The completed unit shall be rigid, true to dimensions and alignment.

3.3 LAYING POTABLE WATER MAINS

- A. Potable water mains shall be laid in accordance with the details shown on the Drawings and as specified herein.
 - 1. The trench bottom shall be graded to the proposed elevation of the pipeline and the bottom shaped to fit the lower quadrant of the pipe. Holes shall be excavated at each bell so the pipe will be uniformly supported along the entire length of the barrel only. Pipe bedding shall be in compliance with Section Excavation and Backfilling for Utilities and as specified herein.
 - 2. Pipe installation and jointing shall be in strict accordance with the pipe manufacturer's specifications and instructions for the type of pipe used and the applicable standards of the Utility.
 - 3. Any pipe having a defective joint, bell or spigot shall be rejected, removed from the work site and replaced with a sound unit.
 - 4. All pipe shall be installed to the homing mark on the spigot. On field cut pipe, the Contractor shall provide a homing mark on the spigot end in strict accordance with the manufacturer's recommendations.
 - 5. All pipe shall be retained in position so as to maintain alignment and joint closure until sufficient haunching and backfill has been placed to adequately hold the pipe in place.
 - 6. Foreign materials shall be prevented from entering the pipe while pipe is being placed in the trench. No debris, tools, articles of clothing or other materials shall be placed in the pipe at any time.
 - 7. At all times when pipe laying is not in progress for ten (10) minutes or more, the open ends of the pipe shall be closed by a watertight plug or other approved means to insure that absolute cleanliness is maintained inside the pipe at all times
 - 8. Laying conditions for potable water systems shall be in accordance with ASTM D746.
 - a. Ordinary bedding conditions, having a load factor of 1.5 shall be used for 16 inch diameter pipe and smaller.
 - b. First Class bedding conditions, having a load factor of not less than 1.5 shall be used for 18 inch to 30 inch pipe.
 - c. Pipe 36 inches and larger shall have first class bedding with a load factor of not less than 1.9.

JFL – THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

3.4 JOINTING POTABLE WATER MAINS

- A. Pipe installation and jointing shall be in strict accordance with the pipe manufacturer's specifications and instructions for the type of pipe used and the applicable standards of the Utility. Joints shall be in strict accordance with AWWA C600, latest revision.
- B. The Contractor shall take all reasonable precautions to provide assurance that the interior of the pipe and the jointing seal shall be free from sand, dirt, trash or other foreign material before installation in the line. Any pipe or fitting that has been installed containing dirt or other detrital material shall be removed, cleaned and relaid. Extreme care shall be taken to keep the bells of the pipe free from sand, dirt or rocks so that the joint may be properly assembled without over stressing the bells.
- C. All pipe shall be installed to the homing mark on the spigot. When field cutting of pipe is required, cutting shall be done by machine, leaving a smooth cut at right angles to the axis of the pipe. Cut ends of pipe to be used with push-on bell shall be beveled to conform to the manufacturers spigot end. Care shall be taken to prevent damage to linings.
- D. Deflection at pipe joints shall not exceed one half (1/2) the maximum pipe deflection recommended by the pipe manufacturer. If at any time joint deflections exceed one half (1/2) the manufacturer's maximum recommended pipe deflections, an appropriate fitting shall be used.

3.5 BACKFILLING, COMPACTION AND TESTING

- A. Refer to Section Excavation and Backfilling for Utilities.
- B. The Contractor shall not perform any backfilling operations other than those that are necessary to hold the pipe in place until soil test samples have been taken, locations recorded, the pipeline tested, inspected and released for backfilling.

3.6 CONNECTIONS FROM NEW TO EXISTING WATER MAINS

- A. No connections will be allowed from new to existing potable water mains not shown on the Drawings without written approval from the Owner and utility owner, as applicable.
 - 1. Approval will be made only after a request form for alteration or connection has been submitted with approved plans.
 - 2. The use of fire hydrants by other than authorized persons is prohibited. The Owner may permit the use of water from a fire hydrant for construction or other purposes provided the applicant shall properly meet the conditions of these Specifications and as shown in the appropriate standard. The installation shall be under the supervision of a representative of the Owner.
 - 3. Valves shall not be operated by any person other than Owner's or utility owner's personnel, as applicable.

3.7 FLUSHING

JFL – THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 07287000 POTABLE & REUSE WATER DISTRIBUTION SYSTEMS Section 33 11 10 - 11

- A. Foreign material left in the pipelines during installation often result in valve and fire hydrant seat leakage during hydrostatic pressure testing. The Contractor shall make every effort to ensure that lines are kept clean during installation.
- B. Thorough flushing is required prior to hydrostatic pressure testing; flushing shall be accomplished by partially opening valves and fire hydrants several times under actual line pressures with pipeline velocities of not less than 3.0 feet per second in the largest line size to be flushed.
 - 1. The pipelines shall be flushed full bore and shall not be less than three (3) times the total volume of the section being tested.

3.8 PRESSURE AND LEAKAGE TESTING:

- A. Hydrostatic pressure and leakage testing of water mains shall be performed by the Contractor in accordance with the latest jurisdiction having authority specifications. All testing shall be made using water. Air testing shall not be permitted.
 - 1. The Contractor shall furnish all gauges, meters, pressure pumps, and all other equipment required to pressure test the main at no additional cost to the Owner.
 - 2. All sections which fail to meet the tests shall be repaired and the leakage eliminated, regardless of the total leakage as shown by the test.
 - 3. All lines which fail to meet the tests shall be repaired and retested as necessary until the test requirements are complied with, at no additional cost to the Owner or the Utility. All defective materials, pipes, valves, and appurtenances shall be removed and replaced at the Contractor's expense.
 - 4. If the Engineer agrees that further construction works are believed to have affected the integrity of a previously tested section, that section shall be re-tested at the Contractor's expense.
- B. The required pressure for the field hydrostatic pressure test shall be as follows.
 - 1. The Contractor shall provide all temporary plugs and blocking necessary to maintain the required test pressure. Corporation cocks, service saddles, pipe risers and angle globe valves shall be provided at each dead-end in order to bleed air from the main. The cost of these items shall be included as part of the testing.
 - 2. The duration of the pressure test shall be a minimum of two (2) hours. The costs of all required items shall be included as part of the testing.

C. TEST PRESSURE RESTRICTIONS:

- 1. Test pressures shall not exceed the pipe or thrust-restraint design.
- D. PRESSURIZATION OF THE LINES:
 - 1. Each valved section of the pipe shall be slowly filled with water and pressurized to the specified test pressure based on the elevation of the lowest point of the line or section under test, and corrected to the elevation of the test gauge by means of a force pump connected to the pipe in a manner satisfactory to the Utility.

- E. AIR REMOVAL BEFORE TESTING:
 - 1. Prior to applying the specified test pressure, all air shall be expelled from the pipe, valves and hydrants.
 - 2. If permanent air relief valves or air vents are not located at all high points, the Contractor shall install corporation cocks at such points so that all air can be expelled as the line is filled with water.
 - 3. After all air has been expelled from the line, the corporation cocks shall be closed and the test pressure applied.

F. EXAMINATION UNDER PRESSURE:

- 1. All exposed pipe, fittings, valves, hydrants, joints, etc. shall be carefully examined during the test. Defective or damaged pipe, fittings, valves or other appurtenances that are discovered following the pressure test shall be repaired or replaced with sound material, and the test shall be repeated until satisfactory to the Utility.
- G. ACCEPTANCE OF THE INSTALLATION:
 - 1. Zero leakage is allowed for the entirety of the two-hour test.
 - 2. If any test discloses leakage greater than the amount specified above, the Contractor shall, at his own expense, locate and make repairs as necessary until the leakage is within the specified allowance. All visible leaks shall be repaired regardless of the amount of leakage.

3.9 DISINFECTION OF POTABLE WATER PIPELINES

- A. Prior to placing the water system in service, all potable water pipelines shall be chlorinated by_in accordance with AWWA C-651, latest edition "AWWA Standard for Disinfecting Water Mains".
- B. The Contractor shall notify the Utility not less than five (5) working days prior to commencement of disinfection of the lines and shall present his plan for chlorination to the Engineer for approval.
- C. The location of the sampling points and chlorination points shall be determined by the Engineer and shall include all locations referenced in the required permits. All taps for chlorination and sampling shall be uncovered and backfilled by the Contractor at no additional expense to the Owner.
- D. After the line has been tested and accepted, the corporation cocks shall be removed and plugged, or left in place at the discretion of the Utility. The Contractor shall repair any damage to pipe exterior coating prior to acceptance.
- E. General procedure for disinfection of potable water systems.
 - 1. Prevent contaminating materials from entering the water main during construction, repair or storage.
 - 2. Remove by flushing any detrital material that may have entered the water main during construction.

JFL – THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

JFL

- 3. Chlorinate any residual contamination that may remain in the lines through a tap at one end of the line.
- 4. Flush chlorinated water from the main after the required minimum detention time of 24 hours.
- 5. Determine the bacteriological quality of the water by laboratory examination in accordance with "Standard Methods For the Examination of Water or Wastewater" or AWWA Manual M12.

F. FILLING AND CONTACT:

- 1. When installation has been completed, and flushed clean, the Contractor shall fill the main with water from the existing water distribution system or other approved source of supply and the water mains shall be made to flow at a constant measured velocity no greater than 1.0 foot per second into the newly laid water main. The Contractor shall furnish a water meter or other approved device for measuring the rate of flow at no additional cost to the Owner.
 - a. At a point not more than 2.0 feet downstream from the beginning of the new main, the entering water shall be dosed with a 1.0 percent chlorine solution, fed at a constant rate, such that the water will have a free chlorine residual of not less than $25 \text{ mg/}\ell$ at the end of a 24-hour holding period.
 - b. To assure that this concentration is provided, the Contractor shall provide testing services to measure the chlorine concentration at regular intervals, in accordance with the procedures described in the current edition of "Standard Methods For the Examination of Water or Wastewater", or AWWA Manual M12. Approved standard chlorine test kits may be used.
 - c. The following table gives the amount of chlorine required for each 100-feet of pipeline of various diameters. Solutions of 1-percent may be prepared using sodium hypochlorite or calcium hypochlorite. (Note: Calcium hypochlorite requires one pound of CaCl2 to 8 gallons of water to provide the required chlorine concentration.)

CHLORINE REQUIRED TO PRODUCE 25mg/L CONCENTRATION IN 100-FT. OF PIPE BY DIAMETER					
PIPE DIA. (INCHES)	100% CHLORINE (lbs./100 Feet Pipe)	1.0% CHLORINE SOLUTION (lbs. NaOCl/Gal.) Water)			
4	0.013	0.16			
6	0.030	0.36			
8	0.054	0.65			
10	0.085	1.02			
12	0.120	1.44			
16	0.217	2.60			
24	0.411	4.90			

JFL – THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

- d. During the application of chlorine, valves shall be positioned and operated so that the strong chlorine solution in the main being treated will not flow into connecting water mains that are in active service.
- e. Chlorine application shall not cease until the entire main is filled with heavily chlorinated water. The chlorinated water shall be retained in the main for not less than 24 hours, during which time all valves, hydrants and appurtenances in the treated section shall be operated to insure complete disinfection. At the end of the 24 hour period, the treated water in all portions of the main shall have a residual of not less than 10 mg/ ℓ of free chlorine.
- f. Hypochlorite solutions shall be applied to the water main using a gasoline powered or electrically powered chemical-feed pump designed for feeding chlorine solutions at a controlled rate of flow. Feed lines shall be of such material and strength as to safely withstand the corrosion caused by the concentrated chlorine solutions and the pressures created by the pumps. All connections shall be checked for tightness before solution is applied to the main.

G. FINAL FLUSHING:

1. After the 24-hour retention period, the heavily chlorinated water shall be flushed from the main until the chlorine residual measurements show that the concentration in the water does not exceed 3.0 mg/ ℓ , but is not less than 0.5 mg/ ℓ .

H. DISPOSING OF HEAVILY CHLORINATED WATER :

- 1. Heavily chlorinated water shall not be discharged into lakes, ponds, reservoirs, canals or streams. The environment to which the chlorinated water is to be discharged shall be inspected and approved by the Utility prior to discharge of chlorinated effluent. If there is any question that the chlorinated discharge will cause damage to the environment, then a dechlorinating agent shall be applied to the water to be wasted to neutralize the chlorine residual remaining in the water.
- 2. The chlorine residual of water being disposed of shall be neutralized by treating with one of the chemicals listed in the following table:

POUNDS OF CHEMICALS REQUIRED TO REDUCE AND NEUTRALIZE VARIED RESIDUAL CHLORINE CONCENTRATIONS IN 100,000 GALLONS OF WATER. *					
RESIDUAL CHLORINE (mg/□)	SULFUR DIOXIDE (SO2)	SODIUM BISULFATE (NaHSO3)	SODIUM SULFITE (NA2SO3)	SODIUM THIOSULFAT E (NA2SO3 5H20)	
1 2 10 50	0.8 1.7 8.3 41.7	1.2 2.5 12.5 62.6	1.4 2.9 14.6 73.0	1.2 2.4 12.0 60.0	

*With the exception of chlorine residual, in mg/l, or P.P.M., all amounts shown above are in pounds.

3. STANDARD CONDITIONS:

- a. After final flushing and before the water main is placed in service, Contractor shall arrange for samples to be collected from the end of the line and shall have them tested for bacteriological quality in accordance with "Standard Methods For the Examination of Water and Wastewater", and shall show the absence of chloroform organisms. A standard plate count shall be required.
- b. Sampling: At least two samples shall be collected from the new main and two from each branch. In the case of extremely long mains (not greater than 1000 linear feet), it is required that samples be collected along the length of the line as well as at its end. The total number of samples and the locations of sampling points shall be as directed by the Engineer, all regulatory agencies as well as the Utility.
- c. Special Conditions: If, during construction, trench water has entered the main, or if in the opinion of the Engineer, excessive quantities of dirt and debris have entered the main, bacteriological samples shall be taken at intervals of not more than 200 feet and shall be identified by station or location. Samples shall be taken of water that has been standing in the main for at least 16 hours after final flushing has been completed.
- d. Sampling Procedures: Samples for bacteriological analysis shall be collected in sterile bottles treated with sodium thiosulfate as required by "Standard Methods for the Examination of Water and Wastewater". Hoses and fire hydrants shall not be allowed in the collection of bacteriological samples. Approved sampling points shall be corporation cocks with gooseneck assemblies and terminal blow-off/sampling tap only.

J. RECHLORINATION

- 1. Should the initial disinfection fail to produce satisfactory bacteriological samples, the main shall be rechlorinated by the continuous feed method until satisfactory results are obtained.
- 2. Should positive bacteriological samples continue to be recorded, the situation shall be evaluated by the Engineer to determine corrective action, and daily samples recorded.
- 3. All retesting shall be at the expense of the Contractor.

JFL – THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 07287000 POTABLE & REUSE WATER DISTRIBUTION SYSTEMS Section 33 11 10 - 16

K. Prior to placing the water system in service, the water system shall be cleared for use, in writing, by the Design Engineer and Owner.

END OF SECTION 331110

JFL – THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 07287000 POTABLE & REUSE WATER DISTRIBUTION SYSTEMS Section 33 11 10 - 17

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Gravity sanitary sewerage collection system including:
 - 1. Gravity sanitary sewer pipe.
 - 2. Manholes.
 - 3. Cleanouts.
 - 4. Alteration of existing sewerage structures.

1.2 **QUALITY ASSURANCE**

- A. Tests and inspections:
 - 1. Procedure: In accord with Division 1.
 - 2. **Required tests:**
 - After alignment tests have been completed, and before flows are allowed in the line, a. conduct leakage tests.
 - b. Test entire system for exfiltration in presence of engineer. Limit leakage to 100 gal. per inch of pipe dia. per mile of length per 24 hr..
 - Limit leakage to stated maximum limit, except that an allowance of an additional c. 10% of gallonage will be allowed for each additional 2 ft. of head over a basic 2 ft. minimum above all pipe soffits.
 - Pay for all leakage tests and required repairs and reconstruction. d.
- B. Reference specifications and standards:
 - 1. AASHTO: Specifications for Highway Bridges.
 - 2. AASHTO: M198 Joints for Circular Concrete Sewer and Culvert Pipe Using Flexible Watertight Gaskets
 - ASTM: A48 Gray Iron Castings. 3.
 - 4. ASTM: A74 Cast Iron Soil Pipe and Fittings.
 - 5. ASTM: A746 (ANSI/AWWA C151/21.51) Ductile Iron Pipe.
 - 6. ASTM: C94 Ready-Mix Concrete.
 - 7. ASTM: C150 Portland Cement.
 - 8. ASTM: C443 Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
 - 9. ASTM: C478 Precast Reinforced Concrete Manhole Sections.
 - 10. ASTM: C923 Watertight Resilient Connectors for Manhole to Pipe Seal.
 - ASTM: D1248 Polyethylene Plastics Molding and Extrusion Materials. 11.

JFL – THS 5 ACRE LAND LE	ASE SITE	Project No. 07287000
Procurement Package		SANITARY SEWER
07/21/2023		GRAVITY SYSTEM
	Harris Civil Engineers	Section 33 33 13 - 1

- ASTM: D1784 Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly 12. (Vinyl Chloride) (CPVC) Compounds.
- ASTM: D2122 Determining Dimension of Thermoplastic Pipe and Fittings. 13.
- 14. ASTM: D2321 Underground Installation of Flexible Thermoplastic Sewer Pipes.
- 15. ASTM: D2412 Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
- 16. ASTM: D3034 Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- ASTM: D3212 Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric 17. Seals.
- ASTM: F477 Elastomeric Seals (Gaskets) for Joining Plastic Pipe. 18.
- 19. ANSI/AWWA: C105/A21.5 Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids.
- 20. ANSI/AWWA: C111/A21.11 Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- 21. ANSI/AWWA: C150/A21.50 Thickness Design of Ductile-Iron Pipe.
- 22. ANSI/AWWA: C151/A21.51 Ductile-Iron Pipe, Centrifugally Cast for Water or Other Liquids.
- C. Allowable tolerances for manhole frames:
 - Horizontal location: Within ± 3 in., in any direction, of horizontal location indicated on 1. Drawings.
 - 2. Vertical alignment: Not greater than 1/8 in. maximum tolerance for 6 ft. of depth.

1.3 **SUBMITTALS**

- A. Procedure: In accord with Division 1 Specifications.
- B. Product data: Manufacturer's detailed technical materials, fabrication, and installation data, including technical bulletins, drawings, guides, and manuals, as applicable to the work of this Project.
- C. Certifications: Manufacturer's certification that pipe and fittings have been inspected and tested at the point of origin, and are in compliance with specified requirements.

PART 2 - PRODUCTS

2.1 **MATERIALS**

- A. Pipe and fittings:
 - Polyvinyl chloride (PVC) pipe and fittings for mainlines 15 in. and smaller: Conform to 1. ASTM D3034, SDR 35.

JFL – THS 5 ACRE LAND LEA	SE SITE	Project No. 07287000
Procurement Package		SANITARY SEWER
07/21/2023		GRAVITY SYSTEM
	Harris Civil Engineers	Section 33 33 13 - 2

- a. Manufacture pipe from approved, Type 1, Grade 1, PVC 12454-C conforming to ASTM D1784 and meeting requirements of ASTM D2122 and ASTM D2412.
- b. Pipe shall have integral wall thickened bells or extruded couplings with gasket seals. Solvent weld joints will not be permitted.
- c. Pipe joints shall be gasket push-on type complying with ASTM D3212 and ASTM F477.
- d. Pipe shall be UL/FM approved.
- e. Fittings shall conform to the same specifications as pipe in which they are to be installed.
- f. Pipe shall be identified on the exterior of the pipe with the following information:
 - (1) Nominal pipe size and o.d. base.
 - (2) Material code designation number (12454C).
 - (3) Dimension ratio number (SDR 35).
 - (4) Pipe Stiffness Designation (PS46).
 - (5) ANSI/ASTM Designation (D3034).
 - (6) Pipe manufacturer's name and production code.
- g. Acceptable manufacturers:
 - (1) Clow.
 - (2) H and W.
 - (3) Certainteed.
 - (4) J-M Manufacturing Company, Inc.
 - (5) Robintech.
- 2. Ductile iron pipe (DIP) and fittings: Conform to ANSI/AWWA C151/A21.51.
 - a. Pipe shall have a minimum tensile strength of 60,000 psi with a minimum yield strength of 42,000 psi.
 - b. Pipe thickness shall be in accord with Table 50.12, ANSI/AWWA C150/A21.50, and shall be Class 50.
 - c. Ductile iron pipe and fittings shall have a minimum of 40 mils thick polyethylene lining in accord with ANSI/AWWA C151/A 21.51 and ASTM D1248. Polyethylene lining shall have sufficient carbon black added to resist ultraviolet rays during storage. Protecto 401 Ceramic Epoxy Lining (by Indurall Coatings, Inc., Birmingham, AL) may be used in lieu of polyethylene lining.
 - d. Pipe shall be supplied in lengths not in excess of a nominal 20 ft., and shall be single gasket, push-on joints (American Fastite or Owner-approved equivalent) conforming to ANSI/AWWA C111/A21.11.
 - e. Pipe shall have a minimum 1 mils bituminous coating on pipe exterior in accord with ANSI/AWWA C151/A21.51.
 - f. Polyethylene encasement, where required, shall be in accord with ANSI/AWWA C105/21.51. Polyethylene tubing shall conform to ASTM D1248.

JFL – THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 07287000 SANITARY SEWER GRAVITY SYSTEM Section 33 33 13 - 3

- g. Acceptable manufacturers:
 - (1) U.S. Pipe.
 - (2) American.
 - (3) Clow.
- 3. Cast iron soil pipe and fittings: Conform to ASTM A74, service weight bell and spigot pipe with the following acceptable gasket types:
 - a. Dual Tite.
 - b. Rich-Seal.
 - c. Ty-Seal.
- B. Precast concrete manhole sections: Precast manhole base sections, barrel sections, eccentric or concentric cone sections, and grade rings shall conform to ASTM C478.
 - 1. Concrete for manhole sections shall be Class A concrete with a compressive strength of 4,000 psi at 28 days conforming to ASTM C94, using ASTM C150 Type II Portland cement.
 - 2. Cure manhole sections by an approved method for a minimum of 4 days prior to painting and shall not be shipped for a minimum of 3 days after having been painted. Manhole sections shall not be shipped for a minimum of 7 days after removal from forms.
 - 3. Interior and mating surfaces shall have a protective coal tar epoxy coating having a minimum dry film thickness of 16 mils. The exterior surfaces shall have a protective coal tar epoxy coating with a minimum dry film thickness of 9 mils.
 - a. Coatings shall be applied by precast manufacturer in accord with coating manufacturer's recommendations.
 - b. Acceptable coating:
 - (1) Carboline (Kop-Coat) Bitumastic 300M.
 - (2) Karlee's Perma-Bar.
 - (3) Owner-approved equivalent.
 - 4. Clearly mark or impress date of manufacture of manhole sections and name or trademark of manufacturer on exterior of each precast section when form is removed and on interior after section has been painted.
 - 5. Cast precast manhole sections with tongue and groove joints, and sealed with Ramnek[™] sealant by the T.K. Snyder Company of Houston, TX or Owner-approved equivalent. Joint sealant shall meet or exceed all requirement of Federal Specifications SS-S-210A and AASHTO M198. Do not use rubber ring manhole joint seals.
 - 6. Precast manhole bases with invert channels cast or formed directly into standard precast concrete manhole bases shall be used except at junctions with existing sewer mains.
 - a. Bench shall be formed smooth and brush finished, and shall slope smoothly and evenly downward at a minimum slope of 3/4 in. per ft. from manhole wall to flow channel. Size and shape of flow channel shall conform to lower 8/10 dia. of inlets and outlets.

JFL – THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

Harris Civil Engineers

Project No. 07287000 SANITARY SEWER GRAVITY SYSTEM Section 33 33 13 - 4

- b. When flow line directional changes occur which exceed 45°, an additional flow line drop of 1/10 ft. across manholes shall be provided.
- c. Precast manhole base units shall be of the Moore Base design or Tru-Contour design.
- 7. Acceptable manufacturers:
 - a. Atlantic Precast Concrete, Inc., Sarasota, FL.
 - b. Mack Concrete Industries, Inc., Apopka, FL.
 - c. Southern Precast, Inc., Alachua, FL.
 - d. Taylor Precast, Inc., Deland, FL.
- 8. Shallow or flat top manholes, where depth of cover is less than 4 ft., shall have vertical walls with a flat precast top slab. Precast top slab shall be capable of supporting the overburden plus a live load equivalent to H-20 loading in accord with AASHTO Specifications for Highway Bridges.
- 9. Do not use brick manholes.
- 10. Manholes receiving force main discharges shall have a PVC or fiberglass liner.
- 11. Precast manhole sections shall have a wall thickness conforming to ASTM C478.
- 12. Manhole base sections shall be not less than 8 in. thick and shall be reinforced with No. 5 steel reinforcing bars spaced at 9 in. o.c. each way and shall have No. 4 steel reinforcing steel bars around each opening.
- 13. Precast concrete shall be wet cast. Do not use dry casting or low slump concrete.
- 14. All precast concrete manhole bases shall have a minimum of three proper lifting loops in the base slabs.
- 15. Do not use penetrating lifting holes in any structure. Where non-penetrating lifting holes are approved, their use will not be permitted within 8 in. of joint or pipe penetration.
- 16. Where pipes enter or exit manholes, a neoprene rubber connector shall be used to provide a resilient watertight connection for the penetration into manhole. Watertight resilient manhole connectors shall conform to ASTM C923.
 - a. Resilient connector shall be Kor-N-Seal molded neoprene boot by National Pollution Control Systems, Inc. of Nashua, NH or A-Lok resilient pipe connector by A-Lok Products, Inc. of Tullytown, PA, or Owner-approved equivalent.
 - b. Resilient pipe connectors shall be supplied and installed by manufacturer of precast products.
- 17. Precast concrete grade rings for manhole adjustment shall conform to ASTM C478. Grade rings shall be a minimum of 2 in. thick, a maximum of 5 in. thick, and be reinforced with No. 6 gauge or thicker reinforcing wire. Do not use brick for manhole adjustment.
- 18. Drop manholes shall be provided where pipes enter manhole at an elevation 24 in. or more above invert of receiving manhole.
- 19. Pipe penetrations into manhole walls shall be precast or corebored by mechanical means. Do not use concrete chisels or hand tools.

- 20. Manholes shall be precast units with integral slab and lower ring. Cast-in-place base slab with precast ring walls shall not be approved, except at junctions with existing storm sewers, where saddle manholes are specified, or at locations as directed by Owner.
- C. Manhole frame, cover, and adjustment rings: Gray iron castings conforming to ASTM A48 Class 30 and ASTM C478.
 - 1. Lifting or pick holes shall be non-penetrating.
 - Frames and covers shall be traffic bearing and capable of supporting H-20 loadings in 2. accord with AASHTO Specifications for Highway Bridges.
 - The manhole frame, cover, and adjustment rings shall be as indicated on Drawings. 3.

PART 3 - EXECUTION

3.1 INSTALLATION/PERFORMANCE

- A. Excavating, trenching, backfilling, and compacting: In accord with Section Excavating and Backfilling.
- B. Setting manholes:
 - Carefully place precast manhole base section on prepared foundation so as to be fully and 1. uniformly supported in true alignment, ensuring that penetrating pipes can be installed at proper line and grade.
 - Handle precast manhole units by lifting rings only. a.
 - Place and adjust first precast section to true grade and alignment. Install inlet pipes b. to form an integral watertight unit. Uniformly support sections upon the base structure, and without any bearing directly on penetrating pipes.
 - Place and align precast manholes to provide horizontal location and vertical c. elevations as indicated on Drawings. Installed manhole shall be rigid, true to dimensions and alignment, and watertight.
 - 2. Fully bed manhole frame and cover in mortar, with precast concrete grade rings placed between manhole cone and manhole frame.
 - Precast concrete grade rings shall conform to the specifications for precast concrete a. sections as designated in ASTM C478.
 - b. Precast concrete grade rings shall have a minimum depth of 2 in. and a maximum depth of 5 in.
 - Precast concrete grade rings shall not be used for more than 19 in. of vertical c. adjustment.
 - d. Do not use brick for manhole adjustment.
- C. Pipe laying: Lay pipe as indicated on Drawings, as specified herein, and in compliance with applicable portions of ASTM D2321.
 - Grade trench bottom to indicated elevation of pipeline and shape bottom to fit lower 1. quadrant of pipe. Excavate holes at each bell hub such that pipe will be uniformly supported along entire length of barrel only.

JFL – THS 5 ACRE LAND LEASE SITE Project No. 07287000 Procurement Package SANITARY SEWER 07/21/2023 **GRAVITY SYSTEM** Section 33 33 13 - 6

- 2. Pipe installation and jointing shall be in accord with pipe manufacturer's specifications and instructions for type of pipe used and applicable requirements specified herein. All pipe having a defective joint, bell, or spigot is unacceptable, shall be rejected, removed from site, and replaced with an acceptable unit.
- 3. Commence pipe laying in finished trench at lowest point, or from a point designated by Owner, and lay upgrade from point of connection with all bell ends forward.
- 4. Install pipe to homing mark on spigot. On field cut pipe, provide a homing mark on spigot end in accord with manufacturer's recommendations.
- 5. Maintain pipe alignment and joint closure until sufficient haunching and backfill is in place to adequately hold pipe in position.
- 6. Prevent foreign materials from entering pipe while it is being placed in trench. Do not place debris, tools, articles of clothing, or other materials in pipe at any time.
- 7. As each length of pipe is placed in trench, assemble joints and bring pipe to intended line and grade. Bed and secure pipe in place.
- 8. When pipe laying is delayed for 10 min. or more, close open ends of pipe using a watertight plug or other approved means to ensure that absolute cleanliness is maintained inside pipe.
- 9. At penetrations of manhole and similar structures, smoothly cut penetrating ends of pipe parallel to interior surface of structure. Maximum interior protrusion of pipe shall be the minimum necessary for proper sealing of pipe connection to structure. Use resilient connector when indicated on Drawings.
- D. Pipe jointing:
 - 1. Pipe installation and jointing shall be in accord with pipe manufacturer's specifications and instructions for type of pipe used and applicable requirements specified herein.
 - 2. Ensure that interior of pipe and jointing seal is free of sand, dirt, trash, or other foreign materials before installation. All pipe or fitting that has been installed containing dirt or other deleterious material shall be removed, cleaned, and relaid. Extreme care shall be taken to keep bells of pipe free from sand, dirt, or rocks so that joints may be properly assembled without overstressing bells.

3.2 FIELD QUALITY CONTROL

- A. Alignment: Inspect sanitary sewerage lines to determine if displacement of pipe has occurred during backfilling and compaction.
- B. Correct, at no additional cost, sections of piping that are deficient in material, alignment, grade, or joints.

END OF SECTION 333313

JFL – THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 07287000 SANITARY SEWER GRAVITY SYSTEM Section 33 33 13 - 7

GENERAL

1.1 SUMMARY

- A. Section includes all work required to complete, as indicated by the Contract Documents, and furnish all supplementary items necessary for the proper installation of the storm sewerage system.
- B. Storm sewerage system includes:
 - 1. Storm drains.
 - 2. Catch basins.
 - 3. Manholes.
 - 4. Alteration of existing drainage structures.
 - 5. Retention trench and underdrains.

1.2 DESCRIPTION OF WORK

A. Extent of storm sewage systems work is indicated on drawings and schedules, and by requirements of this section.

1.3 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of storm sewage system's products of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with storm sewage work similar to that required for project.
- C. Codes and Standards:
 - 1. Plumbing Code Compliance: Comply with applicable portions of Florida Department of Transportation Standard Specifications for Road and Bridge Construction, 2014 Edition (FDOT 2014), pertaining to selection and installation of storm sewage system's materials and products.
- D. Environmental Compliance: Comply with applicable portions of the Environmental Impact Analysis applicable Water Management District and Local Storm Water Management Regulations

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for storm sewage system materials and products.
- B. Shop Drawings: Submit shop drawings for storm sewage systems, showing piping materials, size, locations, and inverts. Include details of underground structures, connections, and manholes. Show interface and spatial relationship between piping and proximate structures.

JFL – THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 H

- C. Record Drawings: At project closeout, submit record drawings of installed storm sewage piping and products, in accordance with requirements of Division-1.
- D. Maintenance Data: Submit maintenance data and parts lists for storm sewage system materials and products. Include this data, product data, shop drawings, and record drawings in maintenance manual; in accordance with requirements of Division-1.

1.5 REFERENCES

- A. ASTM: C76 Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
- B. ASTM: C443 Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
- C. ASTM: C478 Precast Reinforced Concrete Manhole Sections.
- D. ASTM: C969-94 Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines.
- E. ASTM D-5034, ASTM D-5035, and ASTM D-3786, latest revisions: Filter Fabric Properties.

PART 2 - PRODUCTS

2.1 PIPES AND PIPE FITTINGS

- A. General: Provide pipes of one of the following materials, of weight/class indicated. Provide pipe fittings and accessories of same material and weight/class as pipes, with joining method as indicated.
 - 1. Cast-Iron Soil Pipe: ASTM A 74, hub and spigot ends, service weight unless otherwise indicated.
 - a. Fittings: Cast-iron hub and spigot complying with ASTM A 74; lead/oakum caulked joints, or compression joints with rubber gaskets complying with ASTM C 564.
 - 2. Reinforced Concrete Pipe: FDOT 2014 Section 556, Class III (of ASTM C76).
 - a. Fittings: Reinforced concrete, same strength as adjoining pipe, tongue-and-groove gasketed joints complying with ASTM C 443.
 - b. Rubber Gaskets: FDOT 2014 Section 942.
 - 3. Polyvinyl Chloride (PVC) Sewer Pipe: or ASTM D 3034, Type PSM, SDR 35.
 - a. Fittings: PVC, ASTM D 3034, elastomeric joints complying with ASTM D 3212 using elastomeric seals complying with ASTM F 477.
 - 4. High Density Polyethylene (HDPE) Pipe
 - a. HDPE Pipe shall be produced from PE3408 pipe grade polyethylene resins, the resins shall meet the engineering requirements as defined by ASTM standard D-1248 for a

Type III, Class C, Category 5, Grade P34 material.

- b. Storm drainage piping shall be N-12, HDPE pipe as manufactured by Advance Drainage Systems, Inc., or approved equal. Pipe shall be corrugated with an integrally formed smooth interior. Pipe shall conform to AASHTO classification "Type S;" and AASHTO M252 and M294 for test methods, dimensions and markings.
- 5. Corrugated Steel Pipe and Pipe Arch: FDOT 2014 SPECIFICATIONS 943, bituminous coated both sides.
- 6. Corrugated Steel Pipe and Pipe Arch: Aluminum coated (Aluminized Type II): AASHTO M274 and AASHTO M36.
- 7. Coupling/Corrugated Steel Pipe and Pipe Arch: AASHTO M36 with rubber or neoprene gaskets, FDOT 2014 SPECIFICATIONS 430-8.1 (all pipe).
- 8. Corrugated Aluminum Pipe and Pipe Arch: AASHTO M196 and AASHTO M211.
- 9. Corrugated Aluminum Pipe with Perforations (360 degree): AASHTO M196 and M211, ASTM B 209 for Alloy Alclade 3004-H34.
- 10. Coupling/Corrugated Aluminum Pipe and Pipe Arch: AASHTO M196 and AASHTO M211 with asphaltic mastic sealant (performed plastic material), (all pipe).
- 11. Filter Fabric: Spun bound polypropylene, "TYPAR," as manufactured by DuPont, Style 3401.
- 12. Bituminous Coating: AASHTO M190.
- 13. Non-shrinking Mortar: Embeco 167 or approved equal.
- 14. Precast Circular Manholes: Precast reinforced concrete per C 478, except wall thickness shall be 1 inch per foot of inside diameter plus 1 inch but 5 inch minimum. All openings shall have minimum steel hoop of #4 wire. Cement shall be Portland Type II. Provide a 6-inch lip on the base.
- 15. Concrete: FDOT 2014 Section 346 (except no pozzolon), 4, 6, 9, 10, 11, 12 and 13. Class II or Class III with minimum 28 day compressive strengths of 3400 psi and 5000 psi, respectively. Use Type II Portland Cement.
- 16. Reinforcement: FDOT 2014 Section 415 (ASTM A615, Grade 60).
- 17. Curing: FDOT 2014 SPECIFICATIONS 925.
- 18. Brick: ASTM C 32, grade MC (hard brick).
- Mortar: For brick sections of manholes mix one (1) part Portland Cement Type II and three (3) parts of sand per FDOT 2014 Section 902-2.2. For mortar plaster use one (1) part cement, two (2) parts sand.
- 20. Manhole Joint Sealer: Pre-formed plastic joint sealer per Federal Specification SS-S-00210 (GSA PSS), "Ram-Nek" as manufactured by the K.T. Snyder Co., Inc., or approved equal, or Portland Cement mortar, 1/2 inch minimum thickness.
- 21. Manhole Frame & Cover: Gray cast iron per ASTM A 48, Class 30 without perforations and suitable for addition of cast iron or steel rings for upward adjustment of top. The word "STORM" shall be cast into the face of the cover equal to that shown in the Standard Detail Drawings in 1-1/2 to 2 inch letters raised flush with the top of the cover. Frame and cover shall be approved equal to U.S. Foundry and Manufacturing Corp. No. 430 (old No. 32 with Type G cover). Frames and covers shall have machine ground seats and have a coating of coal tar pitch varnish.
- 22. Where prefabricated adjustable frames are called for in the Drawings, they shall be approved equal to U.S. Foundry No 560 (old No. 23 with Type G Cover) and comply with the above requirements.
- 23. Inlet Gratings and Frames: Structural steel, FDOT 2014 Section 425-3.2, U.S. Foundry or equal; Gray Cast Iron, FDOT 2014 Section 962-4.1.

JFL – THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

Project No. 07287000 STORM SEWER SYSTEMS Section 33 40 00 - 3

- 24. Bitumastic: Koppers No. 300M, or approved equal.
- 25. Non-shrink Mortar: Embeco 167 or approved equal.
- 26. Forms: Forms shall be either wood or metal, externally secured and braced when feasible, substantial and unyielding, and of adequate strength to contain the concrete and the additional force of vibration consolidation without bulging between supports and without apparent deviation from neat lines, contours and shapes shown in the Drawings.

2.2 UNDERDRAINS

- A. Filter Fabric:
 - 1. All underdrain pipe shall be encased in filter fabric sock per FDOT Standard Specifications for Road and Bridge, 2014 Edition. Section 948-8.
 - 2. Filter Fabric for use in underdrains shall be in accordance governing jurisdiction's specifications.
- B. Underdrain Aggregate:
 - 1. Aggregate for underdrain material shall be clean, flowable, well drained sand with less than 5% by weight passing the 200 sieve.
- C. Corrugated Polyethylene Pipe and Fittings
 - 1. Corrugated polyethylene tubing for use as underdrain shall conform to the requirements of AASHTO M 252, latest edition. Polyethylene tubing shall be delivered in 20 foot lengths (minimum) and shall be fitted, prior to installation, with a filter fabric wrap as described in 2.01A of this Section. Perforations in the pipe shall be punched rather than slit in order to provide positive openings in the pipe.
 - 2. The fittings shall not reduce or impair the overall integrity or function of the pipe line. Couplings shall provide sufficient longitudinal strength to preserve pipe alignment and prevent separation at the joints. Only fittings supplied or recommended by the pipe manufacturer shall be used.
- D. Clean-outs
 - 1. Clean-outs for the underdrain system shall be furnished, as shown in the plans, and shall conform to the applicable details on the Drawings.

2.3 TRENCH DRAINS

- A. Trench Drains to be installed in accordance with manufacturer's recommendations.
- B. Approved Manufacturers: Zurn, ACO, ABT, or approved equal.
- C. Trench drains may be concrete, concrete polymer or plastic. Steel or aluminum trench drains will not be permitted.
- D. Grates are to be selected by landscape architect.

JFL – THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 F

Harris Civil Engineers

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPE AND PIPE FITTINGS

- A. General: Trench excavation and backfill, including sheeting and bracing dewatering, foundation and bedding and furnishing and disposal of materials shall be as specified in Section 312334 of these Standard Specifications, "EXCAVATING AND BACKFILLING FOR UTILITIES" with any additional requirements included herein.
- B. All pipe joints shall be wrapped in filter cloth fabric. Fabric shall be centered on joint and minimum of 24" wide with minimum 12" of overlap on the circumference.
- C. Laying Pipe: Pipe shall be laid "in the dry" true to the lines and grades given with hubs upgrade and tongue fully inserted into the hub. Provide recesses at each joint as required to establish continuous loading conditions along the pipe barrel. Maintain a clean interior as the work progresses. Adequate filtering methods shall be provided to prevent flushing debris and sediment into any receiving waters.
- D. Round Concrete Pipe: ASTM C443-85a.
 - 1. Seal all joints with round rubber gaskets. The gasket and the surface of the joints must be clean and free of grit, dirt and other foreign matter. To facilitate closure of the joint, apply a vegetable soap lubricant immediately prior to closing. Do not apply mortar, joint compound, or other filler which will restrict the flexibility of the gasket joint.
 - 2. Deviations from true alignment or grade, which result in a displacement from the normal position of the gasket of as much as 1/4 inch, or which produce a gap exceeding 1/2 inch between sections of pipe for more than 1/3 of the circumference of the inside of the pipe, will not be acceptable and where such occur the pipe shall be re-laid without additional compensation. Where minor imperfections cause a gap greater than 1/2 inch between pipe sections, the joint will be acceptable provided the gap does not extend more than 1/3 the circumference of the inside of the pipe.
- E. Oval Concrete Pipe: Seal all joints with round rubber gaskets. The gasket and the surface of the joints must be clean and free of grit, dirt and other foreign matter. To facilitate closure of the joint, apply a vegetable soap lubricant immediately prior to closing. Do not apply mortar, joint compound, or other filler which will restrict the flexibility of the gasket joint.
- F. Cast-Iron Soil Pipe: Install in accordance with applicable provisions of CISPI "Cast Iron Soil Pipe & Fittings Handbook."
- G. Plastic Pipe: Install in accordance with manufacturer's installation recommendations, and in accordance with ASTM D 2321.
- H. Cleaning Piping: Clear interior of piping of dirt and other superfluous material as work progresses. Maintain swab or drag in line and pull past each joint as it is completed.
 - 1. In large, accessible piping, brushes and brooms may be used for cleaning.
 - 2. Place plugs in ends of uncompleted conduit at end of day or whenever work stops.
 - 3. Flush lines between manholes if required to remove collected debris.

JFL – THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023

Harris Civil Engineers

- I. Joint Adapters: Make joints between different types of pipe with standard manufactured adapters and fittings intended for that purpose.
- J. Closing Abandoned Utilities: Close open ends of abandoned underground utilities which are indicated to remain in place. Provide sufficiently strong closures to withstand hydro-static or earth pressure which may result after ends of abandoned utilities have been closed.
 - 1. Close open ends of concrete or masonry utilities with not less than 8 inches thick brick masonry bulkheads.
- K. Interior Inspection: Inspect piping to determine whether line displacement or other damage has occurred.
 - 1. Make inspections after lines between manholes, or manhole locations, have been installed and approximately 2 feet of backfill is in place, and again at completion of project.
 - 2. If inspection indicates poor alignment, debris, displaced pipe, infiltration or other defects, correct such defects, and reinspect.
- L. Lay pipe upgrade with the bell end of pipe section upgrade.
- M. During installation, close open ends of pipe with temporary, water-tight plugs to prevent earth, water and other material from entering the pipe.

3.2 INSTALLATION OF UNDERDRAINS

- A. The trench shall be excavated carefully, to such depth as is required to permit the pipe to be laid to the grade desired, and to the dimensions shown on the Drawings.
- B. The pipe with filter fabric sock installed, shall be bedded firmly in the filter aggregate to the correct line and grade. Installation of the pipe shall be in accordance with ASTM Recommended Practice D2321. The upper end of the run of pipe shall be plugged to prevent any filter aggregate from entering the pipe. Lateral connections shall be made with special fittings, as required.
- C. After the pipe has been laid to grade, the pipe shall be firmly held in place by mechanical means while the filter aggregate is placed to a maximum height of five (5) inches \Box one inch (compacted) above the top of the pipe. After the first lift is compacted to the satisfaction of the Engineer, additional aggregate shall be placed and compacted and the remainder of the trench shall be backfilled in lifts with underdrain aggregate. The minimum density of the compacted filter aggregate be 95 percent of the standard density as determined by AASHTO T99 (Method A). The excavation of the trench, the placement of the filter fabric, the installation of the pipe and the placement and compaction of the first lift of filter aggregate shall be accomplished in a single continuous operation.

3.3 STORM SEWER STRUCTURES

A. Fabrication: All structures shall be constructed as shown in the Drawings or Standard Detail Indexes per FDOT SPECIFICATIONS Roadway and Bridge Design Standards 2014 Edition. Structures may be precast concrete or poured in place concrete.

JFL – THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Project No. 07287000 STORM SEWER SYSTEMS Section 33 40 00 - 6

- B. Foundation: Compact the soil beneath the structure to 95 percent of maximum (AASHTO T-180) density. Additionally provide 9 inches of gravel beneath structures with precast bases.
- C. Manhole Base: Construct per Standard Detail Drawings with Type II Portland Cement concrete, Class II or cast as an integral part of the precast section. If the base is poured, form a groove in the base with an accurate manhole ring, shape with a wood float and finish with a hard steel trowel prior to setting. The base shall set a minimum of 24 hours before the manhole construction proceeds. Precast base shall have a minimum of three lifting hooks set in. The base shall extend 6 inches on all sides of the structure.
- D. Joints Precast Structures: Structures without precast integral bottoms shall be set in a bed of mortar to make a watertight joint at the base. Join precast sections with a minimum mortar thickness of 1/2 inch, maximum of 1 inch. Joint sealer may be used as an alternate.
- E. Structure Invert: the bottom of all drainage structures shall be filled with grout to the elevation of the lowest pipe invert entering/leaving the structure. Grout shall consist of a 3:1 sand-cement mixture, or any class concrete.
- F. Manhole Coating: Coat the exterior surface with one coat of Bitumastic at a minimum rate of 375 square feet per gallon, factory applied and "touched-up" in the field.
- G. Manhole Frames and Covers: Set manhole frames and covers to conform to the grades in the Drawings. Set all frames securely in a cement mortar bed and fillet. All covers shall be made flush with existing permanent surfaces except outside the limits of the traveled ways where they should be set approximately 0.2 foot above the existing ground unless otherwise noted in the Drawings.
- H. Manholes Watertightness: When tested by plugging all inlets and the outlet and filling the structure to within one foot of the cone section or top, with a minimum depth of 4 feet and maximum depth of 20 feet, the maximum allowable drop of the water surface shall be 1/2 inch per 15 minute interval. Contractor shall plug all leaks by method approved by the Engineer.
- I. Pipe Connections: Seal pipes into structure openings with non-shrinking mortar. Provide one joint immediately outside the structure wall. Openings into existing structures shall be cut with a power driven abrasive wheel or saw.

3.4 BACKFILLING

A. General: Conduct backfill operations of open cut trenches closely following laying, jointing, and bedding of pipe, and after initial inspection and testing are completed.

3.5 FIELD QUALITY CONTROL

A. Lamping: Lamp all sewers between manholes, and catch basins after the backfill has been compacted to determine that they are clear of debris and to the correct alignment. The concentricity of the lamp image received shall not vary in the vertical direction but may vary up to 20 percent in the horizontal direction.

JFL – THS 5 ACRE LAND LEASE SITE Procurement Package 07/21/2023 Ha

B. Inspection: Final visual inspection shall be made after all structures are raised to finished grade and the roadway installed. If the lines are unclean, clean-up and re-lamping shall be initiated. Contractor shall assist the engineer during this inspection.

END OF SECTION 334000