PROJECT: **Lovington Fire Station # 2**
WDG PROJECT NO: **445-01**
DATE: **July 05, 2018**

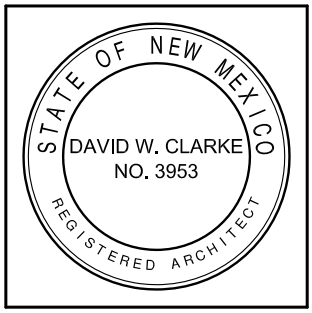
ADDENDUM NO. 3

NOTICE TO PROPOSERS: This Addendum forms a part of the Contract Documents and modifies the original Specifications and Drawings for Lovington Fire Station # 2, dated June 30, 2017 (drawings) and July 5th, 2018 (specifications.)

Acknowledge receipt of this Addendum in the space provided in the Proposal Form. Failure to do so may disqualify the Bidder.

David W. Clarke

July 05, 2018
Date



SPECIFICATIONS:

A) Replace Project Manual Specification Volume 2 in its entirety. Specification Volume 2 will be replaced in all "plan room" locations and on City of Lovington website. The cover page of updated project manual will be noted "Addendum # 3 July 6th, 2018"

DRAWINGS:

A) None

ATTACHMENTS:

1. **None**

END OF ADDENDUM NO. 3

PROJECT MANUAL

VOLUME TWO

CITY OF LOVINGTON, NEW MEXICO

FIRE STATION #2

July 5th, 2018

Addendum # 3 July 6th, 2018

WDG PROJECT # 445-01

TESKE ARCHITECTS
1000 North Turner,
Hobbs, NM 88240

WDG ARCHITECTS
1014 South Main Street, Ste. A
Las Cruces, NM 88005

PROJECT MANUAL
VOLUME TWO

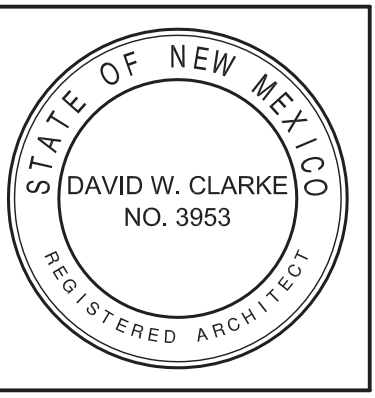
CITY OF LOVINGTON, NEW MEXICO

FIRE STATION # 2

July 5th, 2018

WDG PROJECT # 445-01

City of Lovington, New Mexico
214 South Love Street.
Lovington, NM 88260



The technical material and data contained in the Specifications were prepared under the supervision and direction of the undersigned, whose seal as a Professional Architect, licensed in the State of New Mexico, is affixed above.

All questions about the meaning or intent of these documents shall be submitted only to the Architect of Record, stated above, in writing.

7 / 5 / 2018
ARCHITECT OF RECORD — DATE

TESKE ARCHITECTS
1000 North Turner,
Hobbs, NM 88240

WDG ARCHITECTS
1014 South Main Street, Ste. A
Las Cruces, NM 88005

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Not Applicable

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SECTION 210500 - COMMON WORK REQUIREMENTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. See General Conditions and Supplemental General Conditions.

B. The requirements listed under General Conditions and Supplemental General Conditions and the General Requirements are applicable to this section and all subsequent sections of Division 21 and form a part of the contract.

C. Division 22 for Plumbing Systems.

D. Division 23 for Heating, Ventilating and Air Conditioning (HVAC) Systems.

E. Division 26 for Electrical Systems.

F. Division 28 for Fire Alarm Systems.

G. Division 31, for Trenching, Backfilling and Compaction requirements.

H. Division 33 for requirements of site utility systems, including sanitary sewer, storm sewer, domestic water distribution system, fire main water distribution system, and Division 22 section 22-6801 for natural gas service.

I. All electrical work, regardless of voltage which is provided under Division 21 shall comply with the requirements of the National Electric Code (NEC) and Division 26.

1.2 FIRE SUPPRESSION DIVISION INDEX

Section 21 0500	Common Work Requirements for Fire Suppression
Section 21 0503	Trenching and Backfilling for Fire Suppression
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Section 21 0523	Valves for Fire Suppression
Section 21 0548	Vibration and Seismic Control for Fire Suppression
Section 21 0549	Fire Suppression and Electrical Installation Coordination
Section 21 1313	Fire Protection System, Automatic Wet Pipe Sprinkler

1.3 CODES AND PERMITS

A. The fire suppression shall be performed in strict accordance with the applicable provisions of the International Building Code, 2015 Edition; the Uniform Plumbing Code, 2012 Edition; the Uniform Mechanical Code, 2012 Edition and the International Fire Code, 2015 Edition as

adopted and interpreted by the State of New Mexico, City of Lovington, and the National Fire Protection Association (NFPA Regulations), current adopted edition, regarding fire protection, heating and ventilating and air conditioning systems and electrical systems. All materials and labor necessary to comply with rules, regulations and ordinances shall be provided. Where the drawings and/or specifications indicate materials or construction in excess of code requirements, the drawings and/or specifications shall govern. The Contractor shall hold and save the Architect free and harmless from liability of any nature or kind arising from his failure to comply with codes and ordinances.

B. Permits necessary for performance of the work shall be secured and paid for by the Contractor. All utility connections, extensions, and tap fees shall be paid for by the Contractor, unless otherwise specified herein. See Division 33 for all requirements associated with utility permits and fees, connections and extensions.

C. The following lists some applicable codes and standards that shall be followed.

Applicable county and state mechanical, electrical, gas, plumbing, health and sanitary codes, laws and ordinances

National Electrical Manufacturer's Association Standards

National Electrical Code

Underwriters Laboratories, Inc. Standards

American National Standards Institute

American Society for Testing Materials Standards

Standards and requirements of local utility companies

National Fire Protection Association Standards

American Society of Mechanical Engineers Boiler and Pressure Vessel Codes

Occupational Safety and Health Act

The American Society of Sanitary Engineering

1.4 RECORD DRAWINGS

A. See Division 1, for requirements associated with Project Record Drawings.

B. The Contractor shall be responsible to maintain a complete and accurate set of marked up blue-line prints showing information on the installed location and arrangement of all mechanical work, and in particular, where changes were made during construction. The Contractor shall be responsible for keeping record drawings accurate and up-to-date throughout the construction period. Record drawings may be reviewed and checked by the Architect during the construction and in conjunction with review and approval of monthly pay requests. The

Contractor shall include copies of all addenda, RFI's, bulletins, and change orders neatly taped or attached to record drawing set.

C. After installation and acceptance of direct buried underground piping and service lines in trenches, the Contractor shall take 'as-built' measurements, including all depths, prior to commencement of backfilling operations. It will not be sufficient to check off line locations. Definite measurements shall be taken for each service line. The location of buried piping and trench service lines shall be shown on the drawings and dimensioned from fixed points.

1.5 QUALIFICATIONS

A. All mechanics shall be skilled in their respective trade.

B. All welders shall be certified in accordance with the ASME Boiler Test Code, Section IX, latest issue.

1.6 QUALIFICATION PROCEDURES

A. The storage, handling, and transportation of all refrigerants, oils, lubricants, etc. shall be accomplished in strict compliance with all State, local, and Federal Regulations including all requirements set forth by the Environmental Protection Agency (EPA) for the safe handling of regulated refrigerants and materials. The Contractor shall utilize qualified and/or certified personnel and equipment as prescribed by these requirements.

1.7 HAZARDOUS CONDITIONS

A. Protruding metal (bolts, steel angles, etc.) potentially hazardous to maintenance and operation personnel, shall be cut back and/or protected to reduce the risk of injury.

1.8 HAZARD SIGNS

A. Equipment rooms, fan plenums, and similar areas containing moving or rotating parts, or other potentially hazardous environments shall include signs on all doors entering such spaces that shall read similar to the following: "Hazardous Area - Authorized Personnel Only."

B. Confined Spaces: Areas designated by OSHA Standard 1910.146 as a confined space shall be marked with a sign that reads "Confined Space - Entry by authorized personnel only, by permit."

1. "Confined Space" means a space that:

a. Is large enough and so configured that an employee can bodily enter and perform assigned work; and
b. Has limited or restricted means for entry or exit (for example, tanks, vessels, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry); and
c. Is not designed for continuous employee occupancy.

C. The Contractor shall survey the final premises to determine where any such potentially hazardous areas exist. If the Contractor feels that hazards exist which cannot be suitably provided for through the above typical methods, he shall forward in writing his concerns, and request for a decision concerning the referenced hazard, prior to the final inspection of the facilities.

1.9 SUBMITTALS

A. The Contractor shall submit submittal brochures of all equipment, fixtures and materials to be furnished under Division 21, including but not limited to the following:

1. Piping materials, valves, equipment and installation methods, vibration isolation devices, pipe penetration installation methods and products for fire rated assemblies, and all equipment listed on equipment schedules, and in related construction documents.
2. Materials, certification, shop drawings, and other information as specified in the individual Division 21 Specification Sections within this Specification.

B. Unauthorized Substitutions: If substitute materials, equipment or systems are installed without prior review or are installed in a manner which is not in conformance with the requirement of this Specification and for which the Contractor has not received a written review, removal of all the unauthorized materials and installation of those indicated or specified shall be provided at no change in contract amount.

C. All equipment shall be installed in accordance with the manufacturer's recommendations. Provide all accessories and components for optimum operation as recommended by the manufacturer.

D. Expense: All costs for the preparation, correction, delivery, and return of the submittals shall be borne by the Contractor.

E. Submittals and one resubmittal will be reviewed by the Architect/Engineer. If the Contractor fails to provide the required data with his second submittal, he will be charged for the third and subsequent reviews.

F. See Division 1 for additional submission requirements.

G. The Contractor shall submit a maximum of seven (7) copies of submittal brochures for review. Brochures shall be submitted within thirty (30) days after contract award. One (1) copy of all submittals will be retained by the Engineer. The remaining copies will be returned to the Architect. Additional sets of submittals, if required by the Contractor, shall be reproduced by the Contractor from the reviewed and marked sets returned to the Contractor.

H. Complete data must be furnished showing performance, quality and dimensions. No equipment or materials shall be purchased prior to receiving written notification that submittals have been reviewed and marked either "NO EXCEPTIONS TAKEN" or "EXCEPTIONS AS NOTED." Submittals returned marked "EXCEPTIONS AS NOTED" do not require resubmittal provided that the Contractor agrees to comply with all exceptions noted in the submittal, and so states in a letter.

I. Review of Submittals: Submittals will be reviewed with reasonable promptness, but only for conformance with the design concept of the Project and for conformance with the information indicated on the Drawings and stated in the Specifications. Review of a separate item as such will not indicate review of the assembly in which the item functions. Review of submittals shall not relieve the Contractor of responsibility for any deviation from the requirements of the Contract Documents, nor for errors or omissions in the submittals; or for the accuracy of dimensions and quantities, the adequacy of connections, and the proper and acceptable fitting, execution, functioning and completion of the work. Review shall not relieve the Contractor of responsibility for the equipment fitting within the allotted space shown on the drawings with all clearances required for equipment operation, service and maintenance including minimum clearances required by applicable codes, manufacturer's installation instructions and as necessary for proper clearance in front of all electrical panels as defined by the National Electric Code (NEC). Any relocation of mechanical and/or electrical equipment, materials and systems required to comply with minimum clearances shall be provided by the Contractor without additional cost under the Contract.

J. Shop drawings will be returned unchecked unless the following information is included: cover sheet shall be provided for each submittal of equipment, products and material proposed for use on the project. A common cover sheet for similar equipment (example: all air handling units or all fire protection products) is acceptable. The cover sheet shall list equipment by symbol number; reference all pertinent data in the Specifications or on the drawings; provide size and characteristics of the equipment, name of the project and a space large enough to accept a review stamp. The data submitted shall reflect the actual equipment performance under the specified conditions and shall not be a copy of the scheduled data on the drawings. Cover sheet shall clearly identify any deviations from the specifications for submitted equipment, products, and materials.

K. Use of substitutions reviewed and checked by the Engineer does not relieve the Contractor from compliance with the Contract Documents. Contractor shall bear all extra expense resulting from the use of any substitutions where substitutions affect adjoining or related work required in this Division or other Divisions of this Specification.

L. If Contractor substitutes equipment for that drawn to scale on the drawings, he shall prepare a 1/4" = 1'-0" installation drawing for each equipment room where a substitution is made, using dimensions of substituted equipment, and including piping, and electrical equipment requirements, to verify that equipment will fit space with adequate clearances for maintenance. This 1/4" = 1'-0" fabrication drawing shall be submitted for review with the shop drawing submittals of the substitution. Failure to comply with this requirement will result in the shop drawings being returned unchecked.

1.10 COORDINATION DRAWINGS

A. The Contractor shall, in advance of the work, prepare coordination drawings for:

1. Mechanical equipment rooms.
2. Piping and piping chases.
3. Complete fire suppression system piping and sprinkler head layout.
4. Layout of all fire suppression equipment.

B. Show the location of piping openings through the building floors, walls and roofs coordinated with Architectural and Structural, as well as the location and elevations of building fire suppression equipment and systems and piping, coordinated with plumbing, HVAC and electrical systems. Coordination drawings, including plans, elevations and sections, as appropriate, shall clearly show the manner in which the fire suppression systems fit into the available space and coordinates with HVAC and plumbing equipment, ductwork, piping, and electrical equipment, including conduits, light fixtures, motor control centers, transformers, panels, variable frequency drives, etc. Drawings shall demonstrate required code clearances for mechanical and electrical equipments, control panels, etc., and proper operation, maintenance and replacement of fire suppression devices and equipment. Coordination drawings shall be of appropriate scale to satisfy the previously stated purposes, but not smaller than 1/8-inch scale for floor plans and 1/4 scale of equipment rooms and chase areas. Drawings may be composite or may be separate but fully coordinated drawings of the same scale. Every subcontractor must sign-off on coordination drawings prepared by each craft. Failure to sign-off will indicate that subcontractor is proceeding at his own risk. Any cost required to relocate systems to comply with required clearance and equipment installation requirements shall be provided by the Contractor without additional cost under the contract.

C. Seven (7) complete sets of coordination drawings shall be submitted prior to the scheduled start of the work in the area illustrated by the drawings, for the purpose of showing the Contractor's planned method of installation. The objectives of such drawings are to promote carefully planned work sequence and proper coordination, in order to assure the expeditious solutions of problems, and the installation of lines and equipment as contemplated by the contract documents while avoiding or minimizing additional costs to the Contractor and to the Owner.

D. In the event the Contractor, in coordinating the various installations and in planning the method of installation, finds a conflict in location or elevation of any of the mechanical systems, with the structural items or with other construction items, such conflicts shall immediately be documented and submitted for clarification. In doing so, the Contractor shall explain the proposed method of solving the problem, or shall request instructions as to how to proceed if adjustments beyond those of usual trades coordination are necessary.

E. Installation of fire suppression work shall not proceed prior to the submission and completion of the review of the coordination drawings, and any conflicts which are disclosed by the coordination drawings. It is the responsibility of the Contractor to submit the required drawings in a timely manner consistent with the requirements for completing the work covered by this contract within the prescribed contract time.

1.11 USE OF CADD FILES

A. Under certain conditions, the Contractor will be permitted the use of the Engineer's CADD files for documentation of as-builts, submittals, or coordination drawings.

B. The Engineer may require compensation for the time necessary to format the CADD files delivery to the Contractor. Such work will include removal of title blocks, professional for seals, calculations, proprietary information, etc.

C. The Contractor shall complete the enclosed License, Indemnity and Warranty Agreement, complete with contractor's name, address, and Contractor's Representative signature prior to request for CADD file usage.

1.12 PRIOR APPROVAL

A. Prior approval (approval prior to bid) of alternate mechanical equipment suppliers and service providers is not required. Please do not request prior approval. Alternate manufacturers and service providers may be submitted after bid in accordance with the submittal process provided they meet or exceed the specifications and the indicated design intent.

1.13 GUARANTEE-WARRANTY

A. See Division 1 for warranties.

B. The following guarantee is a part of the specifications and shall be binding on the Contractor:

> "The Contractor guarantees that this installation is free from mechanical defects. He agrees to replace or repair any part of the installation which may fail within a period of one year after date established below, provided that such failure is due to defects in the materials or workmanship or to failure to follow the specifications and drawings. Warranty of the Contractor-furnished equipment or systems shall begin on the date the system or equipment is placed in operation for beneficial use of the Owner or occupancy by the Owner, whichever occurs first; such date will be determined in writing, by means of issuing a 'Certificate of Substantial Completion', AIA Form G704," or equivalent.

C. The extent of guarantees or warranties by Equipment and/or Materials Manufacturers shall not diminish the requirements of the Contractor's guarantee-warranty to the Owner.

D. All items of fire suppression equipment shall be provided with a full one (1) year parts and labor warranty, from the date of acceptance by the Owner.

E. Fire pumps including controllers and transfer switches.

PART 2 - PRODUCTS

2.1 QUALITY OF MATERIALS

A. All equipment and materials shall be new, and shall be the standard product of manufacturers regularly engaged in the production of fire suppression equipment and shall be the manufacturer's latest design. Specific equipment, shown in schedules on drawings and specified herein, is to set forth a standard of quality and operation.

B. Hazardous or Environmentally Damaging Materials: Products shall not contain asbestos, mercury, PCBs, or other materials harmful to people or the environment.

2.2 ELECTRICAL WIRING AND CONTROL EQUIPMENT

A. All wiring and conduit shall be furnished and installed as scheduled in Section 21 0549, Fire Suppression and Electrical Installation Coordination, unless otherwise noted or directed.

B. The Contractor shall coordinate completely with all trades and Sub-Contractors as required to ensure that all necessary components of control work are included and fully understood. No additional cost shall accrue to the Owner as a result of lack of such coordination.

C. The fire suppression piping system may be bonded to the electrical ground bus at the electrical service equipment, but shall not under any circumstances be used as the main grounding electrode for the electrical service.

2.3 PAINTING

A. All finish painting of fire suppression systems and equipment will be under "Painting," unless equipment is hereinafter specified to be provided with factory applied finish coats.

B. All equipment shall be provided with factory applied prime finish, unless otherwise specified.

C. Touch-Up: If the factory finish on any equipment is damaged in shipment or during construction of the building, the equipment shall be refinished.

2.4 IDENTIFICATION OF VALVES

A. Each valve shall be provided with a stamped metal tag secured to the valve. Tag shall indicate the valve number, the service and function of each valve and system valve numbers and designations shall be coordinated with existing valve identification. The Contractor shall furnish two sets of prints of drawings showing floor plan for each floor with all valves accurately located and labeled. Submitted drawings shall be neat and easily readable. In addition, the Contractor shall provide a valve chart, typed neatly on 8-1/2" x 11" sheets, listing the number, size, location, function, normal operating position, on each valve installed under Division 21. Tags shall be stamped brass 1-1/2" diameter, and secured to valves by heavy copper figure eight hooks, braided stainless steel wire anchor, or other approved means.

B. Division 21 valve tags shall be coordinated with Division 22 and Division 23 valve tags for coordinated format between each division.

C. Valve tags shall be coordinated with existing facility valve tags and Contractor shall obtain a copy of existing facility valve chart and provide updated valve chart to the Owner's Representative.

2.5 PIPING SYSTEM IDENTIFICATION

A. Means of Identification: All piping shall be identified by each of the means described below. The Contractor shall provide shop drawing submittal data for proposed labeling system materials and manufacturer's recommended installation procedures.

B. Piping Systems shall be identified by means of an identifying legend on color coded background appropriately worded to indicate the "service" name of the pipe as shown on the drawings. Color coded banding shall also be provided. Additionally, an arrow shall be included to indicate the direction of flow through the pipe.

C. Locations of Piping System Identification: The identifying legends and directional arrows described in the paragraphs preceding shall be located at the following points on each piping system:

- Adjacent to each valve in piping system.
- At every point of entry and exit where piping passes through a wall.
- On each pipe riser and junction.
- At a maximum interval of 20 feet on pipe lines exposed and concealed above accessible ceilings.
- Adjacent to all special fittings (regulating valves, etc.) in piping systems.
- At every access door.

D. Piping identification shall meet the standards of the Federal Occupational Safety Health Act (OSHA) which refers to the ANSI Standard A13.1. The following standardized color code scheme shall be used:

Yellow - Hazardous Materials
Green - Liquid Materials of Inherently Low Hazard
Blue - Gaseous Materials of Inherently Low Hazard
Red - Fire Protection Materials

E. The size of letter and length of color field shall conform to the ANSI standard and shall be as follows:

Outside Diameter of Pipe or Covering	Length of Color Field	Size of Letters
------ to 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
2-1/2" to 6"	12"	1-1/4"
8" to 10"	24"	2-1/2"
Over 10"	32"	3-1/2"

F. All pipe labels exposed within mechanical equipment spaces shall be semi-rigid plastic identification markers. Each label shall have appropriately color-coded background with printed legend. Directional flow arrows shall be included on label. Labels shall "snap-on" around pipe without the requirement for adhesive or bonding of piping sizes 3/4" through 5". Labels for piping 6" and larger shall be furnished with spring attachment at each end of label.

Labels shall be "SETMARK" Type SNA, 3/4" through 5" size and Type STR, 6" and larger, as manufactured by Seton Name Plate Corporation, Brady, or equivalent.

G. All pipe labels except pipe labels located exposed within the mechanical equipment spaces shall be vinyl material with permanent adhesive for application to clear dry pipe and/or insulation jacketing. Each label shall have appropriate color-coded background with printed legend. Direction arrows shall be placed next to label to indicate flow direction. Color and size of arrows shall correspond to that of label. Pressure sensitive pipe tape matching the background color of the label shall be placed over each end of the label and completely around the pipe.

H. All piping shall be identified in a manner matching the existing labeling systems.

I. Attach pipe markers to lower quarter of the pipe on horizontal runs and on the centerline of vertical piping where view is not obstructed. Flow indicator arrow shall point away from pipe marker.

J. Provide the following labels, with ANSI/OSHA color for all piping systems as shown on the drawings and as listed below:

Service/Legend	Letter Color	Background Color
Fire Protection Water	White	Red
Fire Auto Sprinkler	White	Red

2.6 IDENTIFICATION OF CONTROL SYSTEM DEVICES

A. All automatic controls, control panels, pressure electric, electric pressure switches, relays and starters shall be clearly tagged and identified.

2.7 UNDERGROUND PIPING SYSTEM IDENTIFICATION

A. Bury a continuous, preprinted, bright colored, plastic ribbon cable marker with each underground pipe regardless of whether encased. Locate directly over buried pipe, 6" to 8" below finished grade. Marker tape used in conjunction with buried plastic piping systems shall be special detector type. Marker tape used in conjunction with buried plastic piping systems shall be special detection type.

2.8 ACCESS DOORS

A. Provide all access doors required for access to valves, controls, or other items for which access is required for either operation or servicing. All costs incurred through failure to perform this function as the proper sequence of this work shall be borne by the Contractor. The type of access door shall be as required by the room finish schedule. Acoustical tile access doors shall be equal to Krueger Style B, Style A for acoustical plaster, Style C-CE for sidewall drywall or plaster construction, or Milcor institutional 10 gauge security/detention access door with

welded joints, welded butt hinge, with detention type deadbolt lock and tamperproof screws.

B. Access doors shall be not less than 24" x 24" in size except that larger panels shall be furnished where required, and panels in tile or other similar patterned ceilings shall have dimensions corresponding to the tile or pattern module.

C. Where access doors are installed in walls required to have a specific fire rating, the access door installed shall be a fire rated access door with UL label, as manufactured by Milcor or equivalent. Access door in 1-hour construction shall be Class C and access doors in 2-hour construction shall be Class B.

PART 3 - EXECUTION

3.1 COOPERATION WITH OTHER TRADES

A. The Contractor shall refer to other parts of these specifications covering the work of other trades which must be carried on in conjunction with the mechanical work so that the construction operations can proceed without harm to the Owner from interference, delay, or absence of coordination. The Contractor shall be responsible for the size and accuracy of all openings.

3.2 DESIGN AND DRAWINGS

A. The complete design for the project fire suppression system including drawings, hydraulic calculations, piping sizing and arrangement, head layouts, equipment selection, etc., shall be the responsibility of Division 21 Contractor. Preparation of the fire suppression system design shall be in accordance with all Division 21 specification requirements, NFPA requirements and Authorities Having Jurisdiction.

B. Should any doubt or question arise in respect to the true meaning of the drawings or specifications, the question shall be submitted in writing.

C. Installation of all fire suppression equipment and piping systems shall be arranged to provide all clearances required for equipment operation, service, and maintenance, including minimum clearances required by applicable codes, manufacturer's installation instructions and as necessary for proper clearance in front of all electrical panels as defined by the National Electric Code (NEC). Piping systems shall not be routed through or above electrical equipment room or electrical equipment space designed within mechanical equipment rooms.

D. The Contractor's attention is directed to the unique architectural design features and consideration associated with this facility which will require significantly greater levels of coordination and cooperation for the work furnished and installed under Division 21 with the associated architectural, structural, and electrical work than is normally necessary for a more typical facility.

E. The installation of all concealed fire suppression systems shall be carefully arranged to fit within the available space without interference with adjacent mechanical, plumbing, structural

and electrical systems. The Contractor shall make all necessary provisions for penetrations of piping, including sleeves and blockouts in structural systems. The exact location of all exposed fire suppression systems, including access doors; sprinkler piping exposed within finished areas; and other equipment and devices as applicable, shall be coordinated with the Architect, who shall have final authority for the acceptance of the work as it specifically relates to the architectural aesthetic design requirements for the facility. In no instance shall the building vapor barrier system be penetrated by the fire suppression system installation without written approval.

3.3 FIELD MEASUREMENTS

A. The Contractor shall verify the dimensions and conditions governing his work at the building. No extra compensation shall be claimed or allowed on account of differences between actual dimensions, including dimensions of equipment, fixtures and materials furnished, and those indicated on the drawings. Contractor shall examine adjoining work, on which his work is dependent for perfect efficiency, and shall report any work which must be corrected. Coordination of all fire suppression work within the building will be the direct responsibility of the Contractor. Review of submittal data in accordance with paragraph "Submittals" shall in no manner relieve the Contractor of responsibility for the proper installation of the fire suppression work within the available space. Installation of equipment and systems within the building space shall be carefully coordinated by the Division 21 Contractor with all building trades. Each contractor shall so harmonize his work with that of the several other trades that it may be installed in the most direct and workmanlike manner without hindering or handicapping the other trades. Piping interferences shall be handled by giving precedence to pipe lines which require a stated grade for proper operation. Sewer lines shall take precedence over water lines in determination of elevations. In all cases, lines requiring a stated grade for their proper operation shall have precedence over electrical conduit and ductwork. Installation of fire suppression, plumbing and HVAC systems within the ceiling cavity shall be in the following order of priority: plumbing waste lines; roof drains; supply, return, outside air, makeup, and exhaust ductwork; fire sprinkler mains; fire sprinkler branch piping and sprinkler runouts; heating hot water and chilled water piping; domestic hot and cold water; control piping, wiring and conduit; miscellaneous special piping systems.

3.4 EQUIPMENT SUPPORT

A. Contractor shall provide support for equipment to the building structure. Contractor shall furnish all necessary structures, inserts, sleeves, and hanging devices for installation of mechanical and plumbing equipment, ductwork and piping, etc. Contractor shall completely coordinate installation of such devices with all trades and Sub-Contractors. Contractor must further verify that the devices and supports are adequate as intended and do not overload the building's structural components in any way.

3.5 SEISMIC SUPPORTS

A. The Contractor shall be responsible for all anchors and connections for the mechanical work to the building structure to prevent damage of equipment and systems due to earthquakes. The complete fire protection systems shall be supported as required to resist stresses produced by

lateral forces as required by NFPA No. 13. Where fire suppression equipment and piping is connected to the building structure, exact method and means of attachment to the structural system shall be approved by the Architect.

B. See Section 21 0548 for additional requirements for seismic supporting of fire suppression equipment and systems.

3.6 PROTECTION OF MATERIALS AND EQUIPMENT

A. The Contractor shall be responsible for the protection of all work, materials and equipment furnished and installed under this section of the specifications, whether incorporated in the building or not.

B. All items of fire suppression equipment and materials, including piping, valves and fittings, etc., shall be protected from damage and contamination. Equipment and materials shall not be stored outside and exposed to weather and ambient conditions without appropriate protection measures and without the approval of the Architect. Equipment shall be delivered to the jobsite and maintained while on the jobsite with all openings, controls and control panels covered with heavy duty polyethylene wrap or other proper means. Equipment and materials where stored within the building shall be protected at all times from construction damage and contamination from dust, dirt, debris, and especially during fireproofing, painting and gyp board sanding and finishing. Unprotected equipment and piping will require special field cleaning by the Contractor prior to acceptance by the Architect.

C. The Contractor shall provide protection for all work where necessary and shall be responsible for all damage done to property, equipment and materials. Storage of materials within the building shall be approved by the Architect prior to such storage.

D. Pipe openings shall be closed with caps or plugs, or covered to prevent lodgment of dirt or trash during the course of installation. At the completion of the work, fire suppression equipment and materials shall be cleaned thoroughly and delivered in a condition satisfactory to the Architect.

3.7 TRENCHING AND BACKFILLING

A. All excavation, trenching and backfilling required for the fire suppression installation shall be provided by this Contractor.

3.8 MANUFACTURER'S INSTRUCTIONS

A. All equipment shall be installed in strict accordance with recommendations of the manufacturer. If such recommendations conflict with plans and specifications, the Contractor shall report such conflicts to the Architect, who shall make such compromises as he deems necessary and desirable.

3.9 TESTS

A. Tests shall be conducted in the presence of the designated and authorized Owner's Representative. The Contractor shall notify the Architect a minimum of one week in advance of scheduled tests. Requirements for testing are specified under the sections covering the various systems. The Contractor shall furnish all necessary equipment, materials, and labor to perform the required tests.

3.10 CERTIFICATIONS

A. Before receiving final payment, the Contractor shall certify in writing that all equipment furnished and all work done is in compliance with the contract documents and all applicable codes. Submit certifications and acceptance certificates, including proof of delivery of O&M manuals, spare parts required, and equipment warranties which shall be bound with O&M manuals.

3.11 CONSTRUCTION SCHEDULE

A. All work furnished and installed under Division 21 of this Specification shall be provided in accordance with the project schedule and schedule requirements as described on the Architectural Drawings and Specifications.

3.12 SITE VISITS AND OBSERVATION OF CONSTRUCTION

A. The design professional shall make periodic visits to the project site at various stages of construction in order to observe the progress and quality of various aspects of the Contractor's work, in order to determine in general if such work is proceeding in accordance with the Contract Documents. This observation, however, shall in no way release the Contractor from his complete responsibility to supervise, direct, and control all construction work and activities. The design team has no authority over, or a responsibility to means, methods, techniques, sequences, or procedures of construction provided by the Contractor or for safety precautions and programs, or for failure by the Contractor to comply with all law, regulations, and codes.

END OF SECTION 210500

DIVISION 21 SUBSTITUTION REQUEST FORM (SRF)

TO: **BRIDGERS & PAXTON CONSULTING ENGINEERS, INC.**
PROJECT: _____

We hereby submit for your consideration the following product instead of the specified item for the above project:

Section: _____ Page: _____ Paragraph/Line: _____ Specified Item: _____

Proposed Substitution: _____

Attach complete product description, drawings, photographs, performance and test data, and other information necessary for evaluation. Identify specific Model Numbers, finishes, options, etc.

1. Will changes be required to building design in order to properly install proposed substitutions? YES ☐ NO ☐
   If YES, explain: _____

2. Will the undersigned pay for changes to the building design, including engineering and drawing costs, caused by requested substitutions? YES ☐ NO ☐

3. List differences between proposed substitutions and specified item.

Specified Item	Proposed Substitution
_____	_____
_____	_____
_____	_____

4. Does substitution affect Drawing dimensions? YES ☐ NO ☐

5. What affect does substitution have on other trades? _____

6. Does the manufacturer's warranty for proposed substitution differ from that specified? YES ☐ NO ☐
   If YES, explain: _____

7. Will substitution affect progress schedule? YES ☐ NO ☐
   If YES, explain: _____

8. Will maintenance and service parts be locally available for substitution? YES ☐ NO ☐
   If YES, explain: _____

9. Does proposed product contain asbestos in any form? YES ☐ NO ☐

SUBMITTED BY: Firm: _____ Date: _____
Address: _____
Signature: _____ Telephone: _____

For Engineer's Use Only
Accepted _____ Not Accepted: _____ Received too Late: _____
By: _____ Date: _____
Remarks: _____

LICENSE AGREEMENT FOR CADD DATABASE OR BIM MODEL

PROJECT: _____

LICENSE GRANT: Contractor is granted use of the CADD Database or BIM Model (Database/Model) for the indicated project for the specific purpose of preparing submittal documents for this Project. No other use of the Database/Model is granted. Title to the Database/Model is not transferred to the Contractor. The Database/Model may be of value to the Contractor in preparing submittals, but use of the model does not relieve the contractor of the requirement to verify measurements in the field.

COPYING RESTRICTIONS: Contractor may copy the Database/Model in whole or in part, but only for backup and archival purposes or for use by the Contractor's Subcontractors. Contractor agrees to ensure that any entities that receive the Database/Model from Contractor, either in whole or in part, comply with the terms and conditions of this agreement. Contractor shall safeguard the Database/Model from falling into the hands of parties other than Subcontractors with a legitimate need for it.

WARRANTY: Bridgers & Paxton (B&P) offers this Database/Model without warranty and specifically without express or implied warranty of fitness. If Contractor chooses to use the Database/Model, then he does so at his own risk and without any liability or risk to B&P.

INDEMNITY: Contractor shall to the fullest extent permitted by law, defend, indemnify and hold harmless the Owner, Architect, B&P, their employees and agents from all claims, damages, losses, and attorney fees arising out of or resulting from the use of the Database/Model.

ACKNOWLEDGMENT: Contractor acknowledges that (s)he has read this Agreement, understands it, and agrees to be bound by its terms and conditions.

CONTRACTOR'S REPRESENTATIVE

Signature: _____ Company Name: _____

Name: _____ Address 1: _____

Title: _____ Address 2: _____

Date: _____

SECTION 210503 - TRENCHING AND BACKFILLING FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and the General Requirements.

1.2 SCOPE OF WORK

A. The work in this section includes the furnishing of all labor, materials, equipment, transportation, hauling and services required in connection with the excavation, backfilling, compaction, grading and removal of earth from the site required for the installation of the mechanical work specified herein under Division 21.

B. The Contractor shall provide the services of a qualified underground locator to field locate and mark all existing buried utility lines, public and private, piping, conduits, etc., within the required construction area prior to the start of any trenching or excavation work.

1.3 SAFETY REGULATIONS

A. All work performed under this Section shall conform to the requirements of the General Conditions, Supplemental General Conditions and Safety Requirements for this type of work.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

See Division 23, Section 23 0503, for applicable requirements.

END OF SECTION 210503

SECTION 210504 - PIPE AND PIPE FITTINGS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

B. Lead Ban: All piping, solder and flux used in the installation of piping systems furnished and installed under Division 21, shall be lead free. The term lead free is defined as pipe which does not contain more than 8.0% lead and solder and flux which does not contain more than 0.2% lead.

1.2 RELATED SECTIONS

A. Section 21 0500 for Common Work Requirements for Fire Suppression.

1.3 SUBMITTAL DATA

A. Contractor shall furnish complete submittal data for all piping materials, including manufacturer's specifications, certifications, class, type and schedule. Submittal data shall additionally be furnished for pipe hangers and supports, seismic restraints, pipe sleeves including sealing and fire safing materials and installation.

PART 2 - PRODUCTS

See Division 21, Section 21 1313 for applicable requirements.

PART 3 - EXECUTION

See Division 21, Section 21 1313, for applicable requirements.

END OF SECTION 210504

SECTION 210505 - PIPING SPECIALTIES FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Contractor shall furnish and install all piping specialties necessary for satisfactory operation of the systems. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

1.2 RELATED SECTIONS

A. Section 21 0500, Common Work Requirements for Fire Suppression.

B. Section 21 0504, Pipe and Pipe Fittings for Fire Suppression.

C. Section 21 0523, Valves for Fire Suppression.

D. Section 21 0549, Fire Suppression and Electrical Installation Coordination.

1.3 SUBMITTAL DATA

A. Contractor shall furnish complete submittal data for all piping specialties including manufacturer's specifications, performance characteristics, ratings, installation instructions, certifications and approvals of listing agencies, wiring diagrams, and selection analysis.

PART 2 - PRODUCTS

See Division 23, Section 23 0505, for applicable requirements.

PART 3 - EXECUTION

See Division 23, Section 23 0505, for applicable requirements.

END OF SECTION 210505

SECTION 210523 - VALVES FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 REQUIREMENTS

A. All Valves shall conform with current applicable provisions of the General Conditions, Supplemental General Conditions, and General Requirements.

B. All Valves shall meet the current MSS Specifications covering Bronze & Iron Valves. MSS-SP-80, MSS-SP-70, MSS-SP71, MSS-SP-85 where applicable.

C. Lead Ban: Valves shall be lead free. The term lead free is defined as valves which do not contain more than 8.0% lead.

1.2 RELATED SECTIONS

A. Section 21 0500, Common Work Requirements for Fire Suppression.

B. Section 21 0523, Valve Identification for Fire Suppression.

C. Section 21 0504, Pipe and Pipe Fittings for Fire Suppression.

D. Division 23 for Valves.

1.3 SCOPE

A. Contractor shall furnish and install all valves and accessories necessary for satisfactory operation of the systems.

1.4 VALVE REQUIREMENTS

A. All Fire Suppression system valves shall be UL Listed and FM Approved. See applicable fire suppression system specification sections for additional valve requirements, including hose threads, tamper switches, etc.

B. All Gate, Globe, Check, Ball valves shall be manufactured by Milwaukee, Nibco, Apollo, Stockham, Powell, Crane, Grinnell, or equivalent.

C. Butterfly valves shall be as manufactured by Milwaukee, W. C. Norris, Centerline, Crane, Demco, Keystone, Grinnell, Victaulic, Nibco, or Dezurik, or equivalent.

PART 2 - PRODUCTS

See Division 21, Section 21 1313, for applicable requirements.

PART 3 - EXECUTION

See Division 21, Section 21 1313, for applicable requirements.

END OF SECTION 210523

SECTION 210548 - VIBRATION AND SEISMIC CONTROLS FOR FIRE PROTECTION

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with the applicable provisions of the General Conditions, Supplemental General Conditions, and General Requirements.

1.2 RELATED SECTIONS

A. Section 21 0500, Common Works Requirements for Fire Suppression.

B. Section 21 0504, Pipe and Pipe Fittings.

C. Section 21 0900, Instrumentation and Control for Fire Suppression System.

1.3 SCOPE

A. It shall be understood that the requirements for seismic restraints are in addition to other requirements as specified elsewhere for the support and attachment of equipment and mechanical services, and for the vibration isolation of same equipment. Nothing on the project drawings or specifications shall be interpreted as justification to waive the requirements for seismic restraint as specified herein, shown on the drawings and required by Code.

B. The work under this section shall include furnishing all labor, materials, tools, appliances and equipment, and performing all operations necessary for the complete execution of the installation of seismic snubber restraint assemblies as shown, detailed and/or scheduled on the drawings and/or specified in this section of the specifications.

C. The materials and systems specified in this section shall be provided by the Contractor from a single Seismic Snubber Restraint Materials Manufacturer to assure sole source responsibility for the performance of the seismic restraints used.

D. The seismic snubber restraint materials manufacturer shall be responsible for detailed design for seismic supports, including calculation for size and attachment, signed and sealed by registered State of New Mexico Structural Engineer.

1.4 SUBMITTALS

A. See Section 21 0500 for general requirements for submittal materials. In addition to the requirements contained in Section 21 0500, provide submittal information for all products and materials covered under this Section of the Specifications as listed herein.

B. Furnish complete catalog data on all vibration isolators, restraints, and equipment vibration bases to be utilized for the project in order to establish compliance with the plans and specifications and all code requirements.

C. Furnish complete shop drawing information including construction details for all vibration bases; support points and anchor bolt requirements and locations; method of support for piping; method of isolation for piping passing through the building structure; and location and arrangement of seismic restraints.

D. Manufacturers not listed as approved in 'Part 2 - Products' must submit for prior approval in accordance with provisions contained in Section 23 0500.

E. Drawings shall be reviewed and certified by a registered Professional Engineer, with a minimum of five (5) years working experience in this field, certifying that the submitted seismic restraint system design and anchorage details complies with all specification requirements and applicable codes.

1.5 CODE REQUIREMENTS

A. Seismic restraints shall be provided for equipment, materials and systems furnished and installed under Division 21 of this Specification in accordance with the requirements of the 2012 International Building Code; and NFPA No. 13 for fire protection system as adopted and interpreted by the State of New Mexico and the City of Lovington.

1.6 PROJECT SEISMIC PARAMETERS

A. The following parameters shall are based on Structural Calculations and should be used to evaluate the seismic requirements of the mechanical systems and components. See structural drawings for additional information:

Seismic Use Group	
Seismic Response Coefficients	SDS=0.123 SD1=0.036
Site Soil Class	C
Seismic Design Category	

1.7 SEISMIC RESTRAINT REQUIREMENTS

A. The Contractor shall submit calculations prepared by a State of New Mexico licensed Structural Engineer to substantiate that all items of fire protection equipment and piping systems are properly supported to resist earthquake forces as required herein.

B. All fire protection equipment mounted on vibration isolators shall be provided with seismic restraints securely anchored to the building structure capable of resisting horizontal forces of 100% of their weight and/or in accordance with IBC Requirements.

C. All items of fire protection equipment required for life safety including the fire pump and fire protection systems shall be provided with seismic restraints securely anchored to the building capable of resisting horizontal forces of 100% of their weight and/or in accordance with IBC Requirements.

D. All items of fire protection equipment, except as specified above, and all piping furnished and installed under Division 21 shall be provided with seismic restraints securely anchored to the building capable of resisting horizontal forces of 50% of their weight.

E. Seismic restraint/snubber manufacturer shall be responsible for the structural design of attachment hardware as required to attach seismic restraints/snubbers to both the equipment and supporting structure on vibration isolated equipment, or to directly attach equipment to the building structure for non-isolated equipment.

F. The Contractor shall furnish a complete set of approved shop drawings of all mechanical and electrical equipment which is to be restrained to the seismic restraint manufacturer, from which the selection and design of seismic restraint devices and/or attachment hardware will be completed. The shop drawings furnished shall include, at a minimum, basic equipment layout, length and width dimensions, installed operating weights of the equipment to be restrained and the distribution of weight at the restraint points.

PART 2 - PRODUCTS

See Division 23, Section 23 0548, for applicable requirements.

PART 3 - EXECUTION

See Division 23, Section 23 0548, for applicable requirements.

END OF SECTION 210548

SECTION 210549 - FIRE SUPPRESSION AND ELECTRICAL INSTALLATION COORDINATION

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

1.2 RELATED DIVISIONS AND SECTIONS

A. Section 21 0500, Common Work Results for Fire Suppression.

B. Division 22 for Plumbing Systems.

C. Division 23 for Facility Management System.

D. Division 26 for Electrical.

E. Division 28 for Fire Alarm System.

1.3 SCOPE

A. It is the intention of this section to summarize the coordination of effort defined in the related sections and divisions of this specification.

B. If there is a conflict between this Section and other Sections and Divisions of this specification, this Section shall be the governing and decisive Section.

C. Make all connections to motors and controls for equipment supplied and/or installed under Division 21 according to Table 1.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3.1 INSTALLATION

A. No work shall be performed until the reviewed and marked submittal data have been reissued to the Contractor, unless written permission is obtained from the Architect.

TABLE 1

Item or System	Note	Supplied By (3)	Installed By (3)	Powered By	Control Field Wiring By
Fused and Non-Fused Disconnects	(1)	Div. 26	Div. 26	Div. 26	N/A
Control Relays & Control Transformers	(1)	Div. 21	Div. 21	Div. 26	Div. 21
Fire Alarm System & Interface w/Fire Suppression Systems		Div. 28	Div. 28	Div. 28	Div. 28
Fire Pump Systems, including main pump & jacket pump control panels, automatic transfer switches and remote monitoring panels		Div. 21	Div. 21	Div. 26	Div. 21
Fire Sprinkler System Control - Supervisory Panels & Devices, Including Tamper Switches & Flow Switches		Div. 21	Div. 21	N/A	Div. 28

TABLE NOTES:

1. Unless specified to be supplied with the equipment

END OF SECTION 210549

SECTION 211313 - FIRE PROTECTION SYSTEM, AUTOMATIC WET-PIPE SPRINKLER

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplement General Conditions and the General Requirements.

B. Division 3 for concrete work.

C. Division 26 for electrical work and building fire alarm system.

1.2 RELATED SECTIONS

Section 21 0500	Common Work Requirements
Section 21 0503	Trenching and Backfilling for Mechanical Systems
Section 21 0504	Pipe and Pipe Fittings
Section 21 0505	Piping Specialties
Section 21 0523	Valves
Section 23 0549	Fire Suppression and Electrical Installation Coordination
Section 23 0900	Facility Management System
Section 23 3000	Air Tempering System and Equipment
Section 28 3100	Fire Detection and Alarm

1.3 SCOPE

A. Criteria: This Section covers the requirements for furnishing the design, fabrication, installation, and acceptance testing of a complete automatic wet-pipe sprinkler system.

B. Classification: In accordance with NFPA 13 and 101 requirements and recommendations.

C. Scope of Work: Provide the design, materials, equipment, fabrication, installation, labor, and supervision necessary to install, disinfect, flush, test, and place into service a complete wet-pipe sprinkler system.

1. Fully sprinkle the facility per NFPA-13, the International Building Code, International Fire Code, state and/or local Fire Marshal, and any specific requirements of the Owner's insurance underwriter.

D. Components: Provide all piping, fittings, control valves, check valves, alarm valve (with trim), tamper switches, fire department connection, sprinkler heads, hangers, bracing, test and drain connections, zone flow switches, tamper switches, accessories and incidentals required for a complete installation in accordance with codes and standards referenced in this Section.

E. Protect all fire lines subject to freezing in a manner approved by NFPA. Use anti-freeze loops only as approved by NFPA and the Local Fire Marshal and only with approved backflow protection in accordance with applicable building codes. Electric heat tape will not be permitted.

F. Conform to the applicable provisions of NFPA Standards 13 and 101 and to the requirements of the International Building Code. Unless otherwise shown on the Drawings or specified, all materials and equipment used in the installation of the fire protection systems shall be listed in the UL Fire Protection Equipment Directory, and shall be the latest design of the manufacturer. All fire hoses, threads and adapters shall match the standards of the City of Lovington.

G. Provide temporary fire protection within all areas of the building under construction as required by the building codes and the Fire Marshal.

1.4 QUALITY ASSURANCE

A. All materials and equipment used in the installation of the fire protection systems shall be UL listed and/or FM approved for intended use, unless stated otherwise in these specifications.

B. Contractor Qualifications: Contractor shall be experienced, licensed and regularly engaged in the design, fabrication, and installation of automatic fire protection sprinkler systems.

C. Certification: Welders and brazers shall be qualified per the ASME Boiler and Pressure Vessel Code, Section IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.

D. Employ skilled craftspersons and provide proper supervision to ensure the work is erected in a proper manner. Coordinate the work with existing conditions and other disciplines. Visit the premises and thoroughly understand the details of the work and working conditions, and verify all dimensions in the field. If discrepancies are noted which require clarification of the design intent, submit RFIs prior to performing related work. Lay out all work in a manner to avoid all interferences.

E. The drawings show only approximate building outlines and interior construction details as an aid in understanding the scope of work. Follow the drawings as closely as building construction and the work of other trades will permit. Investigate the structural and finish conditions affecting the work and arrange the work accordingly, providing such fittings, traps, valves, and accessories as may be required to meet such conditions. Field verify all dimensions and conditions governing the work.

F. Do not render inoperative any building system without prior approval. Coordinate necessary shutdowns through seven day advanced written notification.

G. Coordinate all fire protection piping and sprinklers with the ceiling or roof materials, lighting, ductwork, conduits, piping, suspended equipment, structural, and other building obstructions to provide an installation in compliance with the appropriate building codes, and NFPA Standards.

1.5 EXISTING CONDITIONS

A. Examine existing conditions and related work required for the design and installation of the fire suppression system.

B. Perform all field tests and inspections as may be necessary to determine water flow, fire protection and pressure characteristics (static and residual pressure and residual flow) necessary for the design and installation of the fire protection system. Contact the water utility to determine whether they anticipate any degradation in the available water source. Prior to starting design, procurement, and installation, submit to the Owner and Engineer a written report documenting the results of this discussion with the water utility.

1.6 SUBMITTALS

A. See Division 1 and Section 21 0500 for general submittal requirements.

B. Within 45 days after the contract is awarded, provide submittal data for the complete fire suppression system for review.

1. Submit sprinkler system design drawings and hydraulic calculations to the Fire Marshal, the Building Department AHJ, and the Owner's Insurer for review, comment, and approval.

    a. Drawings must be prepared by either a minimum Level 3 NICET Certified Technician, or a professional engineer.
    b. Drawings must be stamped by a professional engineer registered in fire protection.

2. Upon receipt of stamped and approved system design drawings and hydraulic calculations from the Fire Marshal, the Building Department AHJ, and the Owner's Insurer, submit required sets of complete submittal data to the Architect as per spec Section 21 0500.

C. Submit complete data describing all equipment and materials to be furnished including performance, quality, dimensions, and certifications of approving agencies. Include plans showing location and arrangement of water supply connection, control valve, fire department connections, alarm bells, tamper switches, on-site fire main routing, on-site fire hydrants and other equipment to be used; and including head layouts coordinated with lighting, plumbing and air conditioning systems. Submittals shall include the following:

1. Shop drawings.
2. Certifications (after installation and tests are completed).
3. Equipment list.
4. Material list.
5. Installation instructions.
6. Maintenance instructions.
7. Operating instructions.
8. Samples, colors.
9. Welder's certification.
10. Catalog data (appropriate unit identified on cut).

11. Recommended spare parts lists.
12. Verifiable calculations.
13. Nameplate data.

D. Complete Package: Submit fire suppression work as a complete package to permit analysis of the system(s) and its components. Partial submittals will not be accepted.

E. Hydraulic Calculations: Submit computerized hydraulic calculations. Maintain a minimum of 10 percent, but not less than a 5 psi buffer below the final water supply curve after accounting for required hose streams, pipe friction elevation differences, etc. Hydraulic design sprinkler system shall be in accordance with the following:

1. Sprinkler System Occupancy Hazard Classifications:

   a. Office and Public Areas: Light Hazard
   b. Storage Areas: Ordinary Hazard
   c. Equipment Rooms: Ordinary Hazard
   d. Service Areas: Ordinary Hazard

2. Minimum Density Requirements for Automatic Sprinkler Hydraulic Design:

   a. Light Hazard Occupancy: 0.10 gpm over 1500 sf area.
   b. Ordinary Hazard, Group 1 Occupancy: 0.15 gpm over 1500 sf area.
   c. Ordinary Hazard, Group 2 Occupancy: 0.20 gpm over 1500 sf area.
   d. Special Occupancy Hazard: As determined by authority having jurisdiction.

F. Shop Drawings: Minimum 1/8" = 1'0" for plans, and 1/4" = 1'0" for details, with minimum 3/16 inch lettering. Show all piping, sprinklers, hangers, flexible couplings, roof construction, electro-mechanical devices, and occupancy of each area, including ceiling and roof heights as required by NFPA 13. Show hydraulic reference points and remote areas.

G. Record Drawings: Provide mylar reproducible record drawings and AutoCAD 2008 files showing all work under this contract. Indicate any special systems or devices such as dry pendant heads, antifreeze loops, inspector's test connections, etc. Submit record drawings prior to requesting final payment.

1.7 PRODUCT HANDLING

A. Materials and Equipment: Protect materials and equipment from damage during shipping, storage, and installation.

B. Materials and Equipment Installation: Ensure materials and equipment are free of moisture, scale, corrosion, dirt, and other foreign materials prior to installation.

C. Plugs and Cover Plates: Protect flanged openings with gasketed metal cover plates to prevent damage during shipment. Cap or plug all drains, vents, and small piping or gauge connections.

D. Sprinkler Head Protection: Remove frangible bulb protectors after sprinkler heads are installed. Protect sprinkler heads with factory-supplied caps and covers until ceiling installation is complete.

1.8 ENVIRONMENTAL CONDITIONS

A. The sprinkler system and system components shall be designed to operate at an elevation of 3900 feet above sea level and in freezing temperatures when exposed to outside conditions.

1.9 ALARM FACILITIES

A. Provide water flow switches and tamper switches. Integrate these and other required sprinkler system alarm devices into the building fire alarm system provided under Division 26. Coordinate with Division 26, Fire Detection and Alarm, regarding the requirements and location of items provided under this section which must be integrated with the fire alarm system.

B. Provide tamper switches on all required valves and devices used in conjunction with the building fire protection system.

1.10 ELECTRICAL CONNECTIONS

A. The fire alarm system will monitor waterflow indicators, tamper switches, etc., provided under this Section.

PART 2 - PRODUCTS

2.1 GENERAL

A. All material and equipment furnished shall be in accordance with the following requirements and NFPA 13. All fire protection materials and equipment shall be new and unused, shall be free of defects and specifically designed for the use intended, shall conform to the requirements of NFPA 13, and shall be UL listed and FM approved, unless otherwise noted in the Specification.

B. Any deviation to the above requirements shall be submitted to the Architect for approval. The deviation submittal shall be clearly identified as a "deviation."

2.2 PIPING MATERIAL

A. Material Requirement: Automatic sprinkler piping shall be in accordance with this Section and NFPA 13, respectively.

B. Underground piping, to a point 5'0" from the building perimeter, shall be as specified for underground water services in Section 22 6801, Outside Utilities, of this Specification.

C. Underground piping within the building and to a point 5'0" from the building perimeter shall be AWWA Class 200 ductile iron water main pipe and fittings with mechanical joints. Interior of pipe and fittings shall be cement lined. Exterior of pipe and fittings shall be bituminous coating

or equivalent. All changes in direction shall be adequately blocked or strapped to prevent separation of joints.

D. Interior building piping systems shall be black steel pipe ASTM A120, or A53 Grade A or B, ERWQ or BW, Standard wall, Schedule 40. UL and FM approved thin wall (Schedule 10, minimum) ASTM A135 or A795 piping may be utilized for sprinkler system as allowed by NFPA and the Fire Marshal. Piping installed outside or exposed to outdoor ambient conditions shall be galvanized.

2.3 FITTINGS

A. Changes of direction shall be accomplished by the use of fittings suitable for use in sprinkler systems as defined in Article 3-13 of NFPA 13. Fittings installed outside or exposed to outdoor ambient conditions shall be galvanized.

B. Fittings and specials for ductile iron pipe shall be Class 250 to match pipe, conforming to AWWA C110, mechanical flange joint type. All ductile iron fittings shall be cement lined.

C. Fittings for steel pipe shall be cast iron screwed, welded fittings, or UL and FM approved mechanical pipe couplings and fittings as manufactured by Victaulic or equivalent in accordance with requirements specified in Section 21 0504.

2.4 JOINTS

A. Joints shall be provided in accordance with Section 21 0504, Pipe and Pipe Fittings, and the manufacturer's instructions. Threaded joints for thin-wall (Schedule 10) piping shall be provided in strict accordance with NFPA requirements, UL and FM approvals for threadable thin-wall piping.

2.5 UNIONS AND FLANGES

A. Unions and flanges shall be provided in accordance with Section 21 0504, Pipe and Pipe Fittings. Gaskets shall be as recommended by the manufacturer and suitable for service on which used.

2.6 HANGERS AND SUPPORTS

A. See Section 21 0504, Pipe and Pipe Fittings, for general requirements associated with equipment piping systems hangers and supports. Seismic supports for fire protection system shall be provided in accordance with NFPA requirements.

B. All fire protection piping shall be rigidly supported from the building structure by means of adjustable ring type hangers. Piping hangers shall be spaced as specified in NFPA 13, Chapter 2. Piping system shall be installed in an approved manner and shall not overload the structure. The Contractor shall provide additional hangers and steel support members as may be required to distribute the piping weight over several structural members where required or directed. Fire protection piping system shall be supported independent and shall not be attached or supported

from hangers, trapezes, or supports provided for other piping systems or equipment.

2.7 VALVES

A. See Section 21 0523, Valves, for general valve requirements. All valves for fire hose fire department connections shall have threads and adapters to match the standard of the City of Lovington Fire Department. All valves shall be UL listed and FM approved. Valve sizes shall be determined by the approved hydraulic calculations. Outside screw and yoke valves shall be indicated on the approved hydraulic calculations. Tamper switches shall be provided on all valves controlling fire protection system operation, as required by NFPA. Valves shall be rated for working pressure not less than the maximum pressure to be developed at that point in the system under any operating condition.

B. Gate valves 2" and under, shall be bronze body and trim, outside screw and yoke, wedge disc, screwed connections, 400 psi W.O.G. maximum working pressure.

C. Gate valves, 2-1/2" and larger, shall be Class 125 or Class 250, as required, with flanged ends, outside screw and yoke, bronze seals, wedge disc, iron body.

D. Drain valves shall be globe valve or angle body globe valve, with screwed ends, bronze body and trim, 200 psig W.O.G. maximum working pressure. Furnish and install as required by NFPA No. 13.

E. Swing check valves 2" and smaller shall be y-pattern, horizontal swing bronze body, bronze trim, 200 psig W.O.G. screwed connections.

F. Swing check valves 2-1/2" and larger, shall be iron body, clearway swing check, Class 125 or Class 250 as required with flanged or grooved connections.

G. Automatic Ball Drips: Automatic ball drips shall be 1/2" or 3/4" as required normally open, which close when the flow of water through the valve exceeds 4 to 10 gpm, 175 psig working pressure, Underwriters' Laboratories, Inc., or Factory Mutual approved, Standard Fire West No. 5248 or equivalent.

H. Post indicator fire main control valve shall be vertical post type for underground valve control provided as shown on the Drawings, Underwriters' Laboratories, and Factory Mutual approved pattern with approved gate valve and tamper switch. Vertical post indicator shall be Mueller Co. Model A-20804 with Mueller AWWA non-rising stem gate valve, A-2050 Series or equivalent. Wall type indicator shall be Mueller A-20810 or equivalent.

2.8 ALARM CHECK VALVES

A. Furnish complete wet-pipe sprinkler system alarm check valve assembly with all accessories required for system operation, supervision and alarm. Valves shall be UL listed and FM approved, designed to automatically activate electrically and/or hydraulically operated alarms and shall be furnished in the required size and arrangement with either flanged or grooved connections.

B. Furnish retard chamber, pressure gauges, valves, and trim including water motor gong and alarm switch with both normally open and normally closed electrical contacts.

C. Alarm check valve assembly shall be as manufactured by Tyco Fire Products or equivalent.

2.9 PRESSURE GAUGES

A. Pressure gauges shall be designed for use with water. Gauges shall be of the Bourdon type having an enclosed phosphor-bronze type. The moving parts shall be brass or stainless steel except the hairspring, which is phosphor-bronze. The case and ring shall be brass or stainless steel, and the ring shall be either threaded or pressed over the case. Gauges shall be 4-1/2 inch size with dial marking subdivisions no finer than one percent of the maximum scale reading, and shall be accurate to two percent or less. The gauge scale, when possible, shall be at least twice the maximum working pressure. All gauges shall be FM approved and UL listed.

2.10 TAMPER SWITCHES

A. All valves which control water to automatic sprinkler heads shall be equipped with supervisory switches having one normally open contact and one normally closed contact. Valve supervisory switches shall be single pole double throw switching contacts, and shall be housed in a gasketed weathertight enclosure. The supervisory device supplied shall be specifically designed to mount on, and operate reliably with, the type of control valve being monitored. All valve position switches shall be adjusted to transmit a supervisory signal within two revolutions of the valve operating hand wheel or crank (away from its full open position).

2.11 FLOW SWITCHES

A. Water flow switches shall be field adjustable vane-type with pneumatic retard and 175 psi working pressure. Units shall be single pole double throw, normally open, suitable for 24-volt, DC service or as otherwise required to interface with Building Fire Alarm system. Water flow switches shall be adjusted so that the device will transmit a water flow alarm within 90 seconds of opening the inspector's test valve on the sprinkler system. The flow switch shall be furnished and installed under this Section of Specifications and electrically connected under Division 26. Flow switches when required for zoning shall be piped and installed so that only one flow switch actuates when an alarm in that zone is present.

2.12 SPRINKLER HEADS

A. Sprinkler heads and accessories shall be UL listed or FM approved for the intended service, quick response automatic closed type, 165 deg F rated with 1/2" orifice, except as may be otherwise required for the specific application, and subject to NFPA 13 and 101 requirements and recommendations. Sprinkler heads with higher temperature ratings shall be installed in electrical and mechanical equipment areas, in areas where occupancy may generate high ambient temperatures, where installed in the vicinity of heat producing equipment, attic spaces, where exposed to the direct rays of the sun and beneath skylights and windows, and at other such locations as required by NFPA 13.

B. Sprinkler heads installed in unfinished areas without suspended ceilings shall be upright bronze or brass. Sidewall type heads may be used in areas with low headroom as approved by the Fire Marshal.

C. Sprinkler heads in areas with suspended ceilings including toilet facilities, storage rooms, and similar building spaces shall be chrome plated bronze pendant type or white painted finish as selected by the Architect unless otherwise noted. Sidewall heads in finished areas shall be horizontal, chrome plated bronze.

D. For all building areas, except as indicated above, furnish concealed sprinkler heads consisting of sprinkler head installed within brass enclosure assembly with cover plate with white finish or satin chrome, as approved by the Architect.

E. Supply spare heads of each type as required by NFPA 13. Provide a metal cabinet with a sprinkler head wrench for each type head.

F. Provide sprinkler head guards where required by NFPA 13 and where appropriate.

G. Approved Manufacturers: Tyco Fire Products, Viking, or equivalent.

2.13 SYSTEM ACCESSORIES

A. Fire Department Connections: Fire department connections shall be of the type and style shown on the civil and/or fire protection drawings, cast brass body, double clappers, plugs, and attached chains. All exposed surfaces, caps and chains shall be chrome plated. Identification shall be by raised letters on the individual devices, or shall consist of attached escutcheon plates of the same material. Label shall read "AUTO SPKR". The dimension from grade level to the center of the 2-1/2-inch inlets shall be 34 inches (plus or minus 2 inches). Make the fire department connection above the inlet to the alarm valve.

B. Plaques: Main riser plaques shall be 7 inches by 10 inches with four mounting holes (one in each corner), and shall have white lettering on red porcelain with white blank for the "design data." Plaque shall meet all requirements of NFPA 13, Chapter 7.

C. Strainers: Strainers, where required, shall be "Y" type with cast iron body, 30 mesh monel screen, flanged ends, 1-1/2-inch blow down connection discharging to outside, and shall be rated at 175 psi working pressure for cold water service.

D. Splash Blocks: Splash blocks shall be concrete, 12 inches by 24 inches by 4 inches thick. A commercially available splash block may be provided as a suitable alternate.

2.14 ACCESS DOORS

A. All concealed valves, controls, etc., shall be provided with access doors as specified under Section 21 0500, Common Work Requirements.

PART 3 - EXECUTION

3.1 FIELD CONDITIONS

A. Prior to installation the Contractor shall carefully inspect the installed work of all other trades and verify that all such work is complete to the point where the installation of the sprinkler system may properly commence.

B. The Contractor shall verify that the entire sprinkler system may be installed in accordance with all referenced codes, regulations, standards, and the original approved design.

3.2 INSTALLATION

A. General

1. The complete fire protection system shall be installed in accordance with NFPA 13. The project drawings provide general information concerning the system arrangements, equipment, material, sizes, and other requirements and shall be utilized by the Contractor for this purpose. However, the Contractor shall have complete responsibility for the system design and installation in accordance with the requirements of this Specification.
2. All pipe, fittings, valves, equipment, and accessories shall be visually examined to ensure that they are clean and free of all burrs, cracks, and other imperfections before being installed. During the progress of construction, open ends of pipes, fittings, and valves shall be properly protected at all times to prevent admission of foreign matter.

B. Piping

1. Installation of fire sprinkler piping system shall be in accordance with all applicable requirements contained in Section 21 0500 – Common Work Requirements, Section 21 0504 – Pipe and Pipe Fittings, and Section 21 0505 – Piping Specialties.
2. All fire sprinkler piping shall be so arranged and include such devices to separate the system into individual and distinct alarm zones as shown on the contract drawings and as required by NFPA recommendation and the Fire Marshal. A minimum of one zone per floor will be required unless shown otherwise on the contract drawings.
3. Sprinkler piping shall be marked and identified in accordance with Section 21 0500, Common Work Requirements.
4. The arrangements of all piping systems shall conform to Architectural requirements and field conditions, and shall be run straight and direct, forming right angles or parallel lines with building walls and other pipes, and shall be neatly spaced. Offsets will be provided where required. Standard fittings shall be used for offsets. All risers shall be erected plumb and true, and shall be parallel with the walls and other pipes and shall be neatly spaced. All work shall be coordinated with all Sections of Division 21, 22, and 23, and Division 26, "Electrical," in order to avoid interference of pipe and unnecessary cutting of floors and walls.
5. No pipes or other apparatus shall be installed so as to interfere in any way with the full swing of the building doors, access doors, equipment access, etc.
6. Inspector's test and test pipes shall be piped from the end of the most remote branch line of the automatic sprinkler system to the exterior of the building.

7. When trapped capacity is more than five gallons, provide auxiliary drains consisting of a one-inch valve, nipple, and cap. When trapped capacity is less than five gallons, auxiliary drain shall be one-inch nipple and cap or plug.
8. Provide main drain valves at system alarm valves and extend piping to discharge at exterior at a location approved by the Architect. All pipe and fittings downstream of drain valve shall be galvanized.
9. All concrete penetrations shall be sleeved, then grouted and sealed with fire-resistive material that shall be securely held in place.

C. Welding

1. No field welding of sprinkler piping shall be permitted.
2. Headers, risers, feed, crossmains, and branch lines may be shop welded using approved welding fittings. Welding and brazing shall conform to American National Standard Institute for Power Piping, ANSI B 31.10, with Addenda ANSI B 31.10a and ANSI B 31.10b. Welding and torch cutting shall not be permitted as a means of installing or repairing sprinkler systems.
3. Provide a blind flange at each end of welded headers.
4. Welders and brazers shall be certified for welding and/or brazing in accordance with the requirements of ASME Boiler and Pressure Vessel Code, Section IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators. Welders must be certified for work they perform, and certificates shall be checked before the work commences.

D. Alarm Check Valve: Alarm check valves shall be installed with the valve and trim set plumb, and shall be unobstructed. Clear distances shall be as listed below:

Rear:	12 inches
Sides:	18 inches
Front:	24 inches

E. Control Valves: OS&Y fire protection control valves shall be installed so that the stem can be readily seen.

F. Sprinklers and Accessories

1. Sprinkler heads in finished areas are to be installed on a true axis line in both directions with a maximum deviation from the axis line of 1/2" plus or minus. Heads exceeding this shall be removed and reinstalled. Sprinkler heads shall be located in the center of the ceiling tiles, unless otherwise directed.
2. Provide chrome-plated escutcheons where exposed piping passes through finished floors, walls, partitions, and ceilings. Secure plates to pipe with setscrews or spring clips.
3. Provide spare sprinkler head cabinets per NFPA 13.

3.3 EQUIPMENT INSTALLATION

A. Installation of all devices or equipment not specifically covered by these Specifications shall be in accordance with manufacturer's instructions.

3.4 TEMPORARY FIRE PROTECTION

A. During the construction of the building and until the permanent fire extinguishing system has been installed and is in service, temporary fire protection shall be provided as required by the Fire Marshal.

3.5 INSPECTION AND TESTING

A. The complete fire protection systems and piping acceptance testing shall be performed by the Contractor and witnessed. Advance notice shall be given by the Contractor prior to any tests.

B. Inspection Prior to Testing: The Contractor shall submit notification upon completion of the installation of all materials and equipment.

C. Water Piping Disinfection: The Contractor shall furnish all hoses, connections, and equipment to flush piping clear and free of debris and to rinse piping of disinfectant. Flushing per NFPA Figure A-10.10-2.1. All fittings and connections required for water piping, flushing, and disinfection shall be furnished by the Contractor.

D. Chlorine Application: Water from the existing distribution system, or other approved supply source, shall be made to flow at a constant measured rate into the newly installed piping. The water shall receive a minimum chlorine dosage of 300 mg/1. The Contractor shall not allow any anti-freeze glycerine to come in contact with the chlorine. The chlorine shall be applied continuously and for a sufficient period to develop a solid column of chlorinated water that will expose all interior surfaces to a concentration of at least 30 mg/1 for at least three hours. The application shall be checked at a tap near the downstream end of the line by chlorine residual measure. The chlorine residual measurement test shall be performed by the Contractor and the results submitted.

E. Final Flushing: After the applicable retention period, the heavily chlorinated water in the entire system shall be flushed until the chlorine concentration is not higher than that of the source.

F. Pressure Testing: Pressure tests shall consist of at least flushing, hydrostatic testing, and operation testing and shall be performed in strict accordance with the requirements of NFPA 13. For all above-grade piping, test pressure of 200 psi shall be held for a continuous period of two hours with no drop in pressure. Each complete system (main riser with all associated piping and alarms) shall be tested and accepted as a complete unit. System pressure test shall be against a blank test flange and not against a valve seat. Tests may be conducted by the Contractor on small sections of each complete unit for the benefit of the Contractor. An air pressure test may be provided in accordance with NFPA 13. An air pressure of 40 psig shall be pumped up, allowed to stand 24 hours, and all leaks which allow a loss of pressure over 1.5 psig during the 24 hours shall be fixed.

G. Unsatisfactory Tests: If any of the above tests fail to produce satisfactory results, tests shall be repeated at no additional cost to the Owner until satisfactory results have been obtained.

3.6 CERTIFICATION

A. The Contractor shall certify that the system has been installed in accordance with all referenced codes and standards. The Contractor shall submit this certification upon completion of tests.

3.7 MAINTENANCE AND OPERATING INSTRUCTIONS

A. System description, system theory of operation, and system final inspection and acceptance documents of the completed system shall be submitted in a bound book (four copies). The maintenance manuals and instructions shall include a brief description of the type of system installed, routine-type work defined by step-by-step instructions that should be performed to ensure long life and proper operations, and the recommended frequency of performance. The instructions shall also include possible trouble spots with diagnosis and suggested correction of each. The theory of operation brochures shall describe the function of each component or subassembly. A copy of the completed Contractor's Materials and Test Certificate (reference NFPA-13, Chapter 24) shall be included to document the final inspection, operating test, acceptance and placement of system in service.

END OF SECTION 211313

SECTION 220500 - COMMON WORK REQUIREMENTS FOR PLUMBING

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. See General Conditions and Supplemental General Conditions.

B. The requirements listed under General Conditions and Supplemental General Conditions and the General Requirements are applicable to this section and all subsequent Sections of Division 22 and form a part of the contract.

C. Division 21 for Fire Suppression Systems.

D. Division 23 for Heating, Ventilating & Air Conditioning (HVAC) Systems.

E. Division 26 for Electrical Systems.

F. Division 31 and Section 22 0503 for Trenching, Backfilling and Compaction requirements.

G. Division 33 for requirements of site utility systems including sanitary sewer, storm sewer, and domestic water distribution system. Refer to section 22-6801 for natural gas.

H. All electrical work, regardless of voltage which is provided under Division 22 shall comply with the requirements of the National Electric Code (NEC) and Division 26.

1.2 PLUMBING DIVISION INDEX

Section 22 0500	Common Work Requirements for Plumbing
Section 22 0503	Trenching and Backfilling for Plumbing
Section 22 0504	Pipe and Pipe Fittings for Plumbing
Section 22 0505	Piping Specialties for Plumbing
Section 22 0523	Valves for Plumbing
Section 22 0549	Plumbing and Electrical Installation Coordination
Section 22 0700	Plumbing Insulation
Section 22 1100	Domestic Water Piping
Section 22 1123	Facility Natural Gas System
Section 22 1316	Sanitary Waste and Vent Piping
Section 22 1400	Facility Roof Drainage
Section 22 1500	Compressed-Air Systems
Section 22 4000	Plumbing Fixtures and Trim
Section 22 6801	Outside Utilities

1.3 CODES AND PERMITS

A. The plumbing work shall be performed in strict accordance with the applicable provisions of the International Building Code, 2015 Edition; the Uniform Plumbing Code, 2012 Edition; the Uniform Mechanical Code, 2012 Edition and the International Fire Code, 2015 Edition as adopted and interpreted by the State of New Mexico, City of Lovington, and the National Fire Protection Association (NFPA Regulations), current adopted edition, regarding plumbing systems and electrical systems. All materials and labor necessary to comply with rules, regulations and ordinances shall be provided. Where the drawings and/or specifications indicate materials or construction in excess of code requirements, the drawings and/or specifications shall govern. The Contractor shall hold and save the Architect free and harmless from liability of any nature or kind arising from his failure to comply with codes and ordinances.

B. Permits necessary for performance of the work shall be secured and paid for by the Contractor. All utility connections, extensions, meter pits and meter sets and tap fees for water, storm sewer, sanitary sewer and natural gas shall be paid for by the Contractor, unless otherwise specified herein. See Division 33 for all requirements associated with utility permits and fees, connections, extensions, meter pits, and meter sets.

C. The following lists some applicable codes and standards that shall be followed.

Applicable county and state mechanical, electrical, gas, plumbing, health and sanitary codes, laws and ordinances.

National Electrical Manufacturer's Association Standards

National Electrical Code

Underwriters Laboratories, Inc. Standards

American National Standards Institute

American Society for Testing Materials Standards

Standards and requirements of local utility companies.

National Fire Protection Association Standards

American Society of Mechanical Engineers Boiler and Pressure Vessel Codes

Occupational Safety and Health Act

Commercial and Industrial Insulation Standards (MICA)

American Gas Association

The American Society of Sanitary Engineering

National Sanitation Foundation

1.4 RECORD DRAWINGS

A. See Division 1, for requirements associated with Project Record Drawings.

B. The Contractor shall be responsible to maintain a complete and accurate set of marked up blue-line prints showing information on the installed location and arrangement of all plumbing work, and in particular, where changes were made during construction. The Contractor shall be responsible for keeping record drawings accurate and up-to-date throughout the construction period. Record drawings may be reviewed and checked by the Architect during the construction and in conjunction with review and approval of monthly pay requests. Contractor shall include copies of all addenda, RFI's, bulletins, and change orders neatly taped or attached to record drawing set.

C. After installation and acceptance of direct buried underground piping and service lines in trenches, the Contractor shall take ‘as-built’ measurements, including all depths, prior to commencement of backfilling operations. It will not be sufficient to check off line locations. Definite measurements shall be taken for each service line. The location of buried piping and trench service lines shall be shown on the drawings and dimensioned from fixed points.

1.5 QUALIFICATIONS

A. All mechanics shall be skilled in their respective trade.

B. All welders shall be certified in accordance with the ASME Boiler Test Code, Section IX, latest issue.

1.6 QUALIFICATION PROCEDURES

A. The storage, handling, and transportation of all refrigerants, oils, lubricants, etc. shall be accomplished in strict compliance with all State, local, and Federal Regulations including all requirements set forth by the Environmental Protection Agency (EPA) for the safe handling of regulated refrigerants and materials. The Contractor shall utilize qualified and/or certified personnel and equipment as prescribed by these requirements. In no situation shall any refrigerant be discharged to the atmosphere.

1.7 HAZARDOUS CONDITIONS

A. Protruding metal (bolts, steel angles, etc.) potentially hazardous to maintenance and operation personnel, shall be cut back and/or protected to reduce the risk of injury.

1.8 HAZARD SIGNS

A. Equipment rooms, fan plenums, and similar areas containing moving or rotating parts, or other potentially hazardous environments shall include signs on all doors entering such spaces that shall read similar to the following: "Hazardous Area - Authorized Personnel Only."

B. Confined Spaces: Areas designated by OSHA Standard 1910.146 as a confined space shall be marked with a sign that reads "Confined Space - Entry by authorized personnel only, by permit."

1. "Confined Space" means a space that:

a. Is large enough and so configured that an employee can bodily enter and perform assigned work; and
b. Has limited or restricted means for entry or exit (for example, tanks, vessels, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry); and
c. Is not designed for continuous employee occupancy.

C. The Contractor shall survey the final premises to determine where any such potentially hazardous areas exist. If the Contractor feels that hazards exist which cannot be suitably provided for through the above typical methods, he shall forward in writing his concerns, and request for a decision concerning the referenced hazard, prior to the final inspection of the facilities.

1.9 SUBMITTALS

A. The Contractor shall submit submittal brochures of all equipment, fixtures and materials to be furnished under Division 22, including but not limited to the following:

1. Piping materials, valves, insulation materials and installation methods, vibration isolation devices, pipe penetration installation methods and products for fire rated assemblies, and all plumbing equipment listed on equipment schedules, and in related construction documents.
2. Materials, certification, shop drawings, and other information as specified in the individual Division 22 Specification Sections within this Specification.

B. Unauthorized Substitutions: If substitute materials, equipment or systems are installed without prior review or are installed in a manner which is not in conformance with the requirement of this Specification and for which the Contractor has not received a written review, removal of all the unauthorized materials and installation of those indicated or specified shall be provided at no change in contract amount.

C. All equipment shall be installed in accordance with the manufacturer's recommendations. Provide all accessories and components for optimum operation as recommended by the manufacturer.

D. Expense: All costs for the preparation, correction, delivery, and return of the submittals shall be borne by the Contractor.

E. Submittals and one resubmittal will be reviewed by the Architect/Engineer. If the Contractor fails to provide the required data with his second submittal, he will be charged for the third and subsequent reviews.

F. See Division 1 for additional submission requirements.

G. The Contractor shall submit a maximum of seven (7) copies of submittal brochures for review. Brochures shall be submitted within thirty (30) days after contract award. One (1) copy of all submittals will be retained by the Engineer. The remaining copies will be returned to the Architect. Additional sets of submittals, if required by the Contractor, shall be reproduced by the Contractor from the reviewed and marked sets returned to the Contractor.

H. Complete data must be furnished showing performance, quality and dimensions. No equipment or materials shall be purchased prior to receiving written notification that submittals have been reviewed and marked either "NO EXCEPTIONS TAKEN" or "EXCEPTIONS AS NOTED." Submittals returned marked "EXCEPTIONS AS NOTED" do not require resubmittal provided that the Contractor agrees to comply with all exceptions noted in the submittal, and so states in a letter.

I. Review of Submittals: Submittals will be reviewed with reasonable promptness, but only for conformance with the design concept of the Project and for conformance with the information indicated on the Drawings and stated in the Specifications. Review of a separate item as such will not indicate review of the assembly in which the item functions. Review of submittals shall not relieve the Contractor of responsibility for any deviation from the requirements of the Contract Documents, nor for errors or omissions in the submittals; or for the accuracy of dimensions and quantities, the adequacy of connections, and the proper and acceptable fitting, execution, functioning and completion of the work. Review shall not relieve the Contractor of responsibility for the equipment fitting within the allotted space shown on the drawings with all clearances required for equipment operation, service and maintenance including minimum clearances required by applicable codes, manufacturer's installation instructions and as necessary for proper clearance in front of all electrical panels as defined by the National Electric Code (NEC). Any relocation of plumbing and/or electrical equipment, materials and systems required to comply with minimum clearances shall be provided by the Contractor without additional cost under the Contract.

J. Shop drawings will be returned unchecked unless the following information is included: cover sheet shall be provided for each submittal of equipment, products and material proposed for use on the project. A common cover sheet for similar equipment (example: all air handling units or all fire protection products) is acceptable. The cover sheet shall list equipment by symbol number; reference all pertinent data in the Specifications or on the drawings; provide size and characteristics of the equipment, name of the project and a space large enough to accept a review stamp. The data submitted shall reflect the actual equipment performance under the specified conditions and shall not be a copy of the scheduled data on the drawings. Cover sheet shall clearly identify any deviations from the specifications for submitted equipment, products, and materials.

K. Use of substitutions reviewed and checked by the Engineer does not relieve the Contractor from compliance with the Contract Documents. Contractor shall bear all extra expense resulting from the use of any substitutions where substitutions affect adjoining or related work required in this Division or other Divisions of this Specification.

L. If Contractor substitutes equipment for that drawn to scale on the drawings, he shall prepare a 1/4" = 1'-0" installation drawing for each equipment room where a substitution is made, using dimensions of substituted equipment, and including piping, and electrical equipment requirements, to verify that equipment will fit space with adequate clearances for maintenance. This 1/4" = 1'-0" fabrication drawing shall be submitted for review with the shop drawing submittals of the substitution. Failure to comply with this requirement will result in the shop drawings being returned unchecked.

1.10 COORDINATION DRAWINGS

A. The Contractor shall, in advance of the work, prepare coordination drawings for:

1. Equipment rooms, and other spaces housing plumbing and equipment, etc.

2. Layout of all plumbing equipment.

B. Show the location of piping openings through the building floors, walls and roofs coordinated with Architectural and Structural, as well as the location and elevations of building fire suppression equipment and systems, including piping, coordinated with HVAC plumbing, fire suppression and electrical systems. Coordination drawings, including plans, elevations and sections, as appropriate, shall clearly show the manner in which the plumbing systems fit into the available space and coordinates with HVAC and plumbing equipment, ductwork, piping, sprinkler heads, and electrical equipment, including conduits, light fixtures, motor control centers, transformers, panels, variable frequency drives, etc. Drawings shall demonstrate required code clearances for mechanical and electrical equipments, control panels, etc., and proper operation, maintenance and replacement of plumbing devices and equipment. Coordination drawings shall be of appropriate scale to satisfy the previously stated purposes, but not smaller than 1/8 inch scale for floor plans and 1/4 scale of equipment rooms and chase areas. Drawings may be composite or may be separate but fully coordinated drawings of the same scale. Every subcontractor must sign-off on coordination drawings prepared by each craft. Failure to sign-off will indicate that subcontractor is proceeding at his own risk. Any cost required to relocate systems to comply with required clearance and equipment installation requirements shall be provided by the Contractor without additional cost under the contract.

C. Seven (7) complete sets of coordination drawings shall be submitted prior to the scheduled start of the work in the area illustrated by the drawings, for the purpose of showing the Contractor's planned method of installation. The objectives of such drawings are to promote carefully planned work sequence and proper coordination, in order to assure the expeditious solutions of problems, and the installation of lines and equipment as contemplated by the contract documents while avoiding or minimizing additional costs to the Contractor and to the Owner.

D. In the event the Contractor, in coordinating the various installations and in planning the method of installation, finds a conflict in location or elevation of any of the plumbing systems, with the structural items or with other construction items, such conflicts shall immediately be documented and submitted for clarification. In doing so, the Contractor shall explain the proposed method of solving the problem, or shall request instructions as to how to proceed if adjustments beyond those of usual trades coordination are necessary.

E. Installation of plumbing work shall not proceed prior to the submission and completion of the review of the coordination drawings, and any conflicts which are disclosed by the coordination drawings. It is the responsibility of the Contractor to submit the required drawings in a timely manner consistent with the requirements for completing the work covered by this contract within the prescribed contract time.

1.11 USE OF CADD FILES

A. Under certain conditions, the Contractor will be permitted the use of the Engineer's CADD files for documentation of as-builts, submittals, or coordination drawings.

B. The Engineer shall be compensated for the time required to format the CADD files for delivery to the Contractor. Such work may include removal of title blocks, professional seals, calculations, proprietary information, etc.

C. The Contractor shall complete the enclosed License, Indemnity and Warranty Agreement, complete with contractor's name, address, and Contractor's Representative signature prior to request for CADD file usage.

1.12 PRIOR APPROVAL

A. Prior approval (approval prior to bid) of alternate mechanical equipment suppliers and service providers is not required. Please do not request prior approval. Alternate manufacturers and service providers may be submitted after bid in accordance with the submittal process provided they meet or exceed the specifications and the indicated design intent.

1.13 GUARANTEE-WARRANTY

A. See Division 1 for warranties.

B. The following guarantee is a part of the specifications and shall be binding on the Contractor:

> "The Contractor guarantees that this installation is free from defects. He agrees to replace or repair any part of the installation which may fail within a period of one year after date established below, provided that such failure is due to defects in the materials or workmanship or to failure to follow the specifications and drawings. Warranty of the Contractor-furnished equipment or systems shall begin on the date the system or equipment is placed in operation for beneficial use of the Owner or occupancy by the Owner, whichever occurs first; such date will be determined in writing, by means of issuing a 'Certificate of Substantial Completion', AIA Form G704", or equivalent.

C. The extent of guarantees or warranties by Equipment and/or Materials Manufacturers shall not diminish the requirements of the Contractor's guarantee-warranty to the Owner.

D. All items of plumbing equipment shall be provided with a full one (1) year parts and labor warranty, from the date of acceptance by the Owner.

PART 2 - PRODUCTS

2.1 QUALITY OF MATERIALS

A. All equipment and materials shall be new, and shall be the standard product of manufacturers regularly engaged in the production of plumbing equipment and shall be the manufacturer's latest design. Specific equipment, shown in schedules on drawings and specified herein, is to set forth a standard of quality and operation.

B. Hazardous or Environmentally Damaging Materials: Products shall not contain asbestos, mercury, PCS, or other materials harmful to people or the environment.

2.2 ALTITUDE RATINGS

A. Unless otherwise noted, all specified equipment capacities are for an altitude of 3900 feet above sea level and adjustments to manufacturer's ratings must be made accordingly.

2.3 ELECTRICAL SERVICES - MOTORS

A. Each motor, unless otherwise specified of 3/4 HP and greater, shall be designed for operation with 3 phase, 60 Hz, 208 volt electrical service. Unless otherwise specified, motors of 1/2 hp and less shall be designed for operation with single phase, 60 Hz, 120 volt electrical service. Motors shall be 1750 RPM, squirrel cage, normal starting torque and normal starting current, in accordance with NEMA standards unless otherwise specified.

B. Motors, including premium efficiency motors shall be manufactured by General Electric Baldor, Louis Allis (Spartan), Marathon, Reliance Electric, Westinghouse, or equivalent having equal efficiencies.

C. Special motors as may be necessary by the application and as specified herein and on the drawings include C-FACE, totally enclosed fan cooled (TEFC),explosion-proof, etc., shall be provided as required and shall be furnished manufacturer’s premium efficiency rating for 5 HP and larger.

D. Each motor shall be of the horsepower as specified and suitable for use at an altitude of 3900 feet. All motors shall have grease lubricated sealed ball bearings. Motors larger than 1 HP shall have a standard grease fitting "Zerk" and a separate grease relief tapping. Motors shall be factory lubricated. Motors shall be commercially dynamically balanced and tested at the factory before shipment and shall be selected for quiet operation. The Contractor shall line up motors and drives and place motors and equipment on foundations ready for operation.

E. Unless indicated otherwise, motors shall be NEMA design B with a service factor of 1.15 with 40^0C rise and total temperature rise of 65^oC ambient and when powered from the system voltage feeding the motor. TEFC motors shall have a service factor of 1.00 with total temperature rise of 65^oC in the above conditions. Motors located in areas exceeding 40^oC in the ambient shall be factory rated for the ambient temperature of the motor environment. Single phase motors shall generally be NEMA Type N split phase induction motors with built-in thermal protectors. Unless otherwise specified for a particular application use electric motors with the following requirements.

1. Single-phase Motors: Capacitor-start type for hard starting applications. Motors for centrifugal fans and pumps may be split phase or permanent split capacitor (PSC).
2. Polyphase Motors: NEMA Design B, Squirrel cage, induction type. Each two speed motor shall have two separate windings.
3. Rating: Continuous duty at 100% capacity in an ambient temperature of 40^oC.

F. If the Division 22 Contractor proposes to furnish motors varying in horsepower and/or characteristics from those specified, he shall first submit his request for the change and shall then coordinate the change with Division 26 and shall pay all additional charges in connection with the change.

G. The Contractor shall ensure proper coordination between motors and variable frequency drives. See Section 22 0550 also.

2.4 ELECTRICAL WIRING AND CONTROL EQUIPMENT

A. All wiring and conduit shall be furnished and installed as scheduled in Section 22 0549, Plumbing and Electrical Installation Coordination, unless otherwise noted or directed.

B. The Contractor shall coordinate completely with all trades and Sub-Contractors as required to ensure that all necessary components of control work are included and fully understood. No additional cost shall accrue to the Owner as a result of lack of such coordination.

C. The piping system may be bonded to the electrical ground bus at the electrical service equipment, but shall not under any circumstances be used as the main grounding electrode for the electrical service.

2.5 PAINTING

A. All finish painting of plumbing systems and equipment will be under "Painting," unless equipment is hereinafter specified to be provided with factory applied finish coats.

B. All equipment shall be provided with factory applied prime finish, unless otherwise specified.

C. Touch-Up: If the factory finish on any equipment is damaged in shipment or during construction of the building, the equipment shall be refinished.

2.6 COUPLING GUARDS

A. All flexibly connected pumps shall be provided with protective steel coupling guards.

2.7 IDENTIFICATION OF VALVES

A. Each valve shall be provided with a stamped metal tag secured to the valve. Tag shall indicate the valve number, the service and function of each valve. The Contractor shall furnish two sets of prints of drawings showing floor plan for each floor with all valves accurately located and labeled. Submitted drawings shall be neat and easily readable. In addition, the Contractor shall provide a valve chart, typed neatly on 8-1/2" x 11" sheets, listing the number, size, location, function, normal operating position, on each valve installed under Division 22. Valves shall be listed by system, i.e. domestic cold water, hot water, chilled water etc. Tags shall be stamped brass 1-1/2" diameter, and secured to valves by heavy copper figure eight hooks, braided stainless steel wire anchor, or other approved means.

B. Division 22 valve tags shall be coordinated with Division 21 and Division 23 valve tags for coordinated format between each Division.

C. Valve tags shall be coordinated with existing facility valve tags and Contractor shall obtain a copy of existing facility valve chart and provide updated valve chart to the Owner’s Representative.

2.8 PIPING SYSTEM IDENTIFICATION

A. Means of Identification: All piping shall be identified by each of the means described below. The Contractor shall provide shop drawing submittal data for proposed labeling system materials and manufacturer's recommended installation procedures.

B. Piping Systems shall be identified by means of an identifying legend on color coded background appropriately worded to indicate the "service" name of the pipe as shown on the drawings. Color coded banding shall also be provided. Additionally, an arrow shall be included to indicate the direction of flow through the pipe.

C. Locations of Piping System Identification: The identifying legends and directional arrows described in the paragraphs preceding shall be located at the following points on each piping system:

- Adjacent to each valve in piping system.
- At every point of entry and exit where piping passes through a wall.
- On each pipe riser and junction.
- At a maximum interval of 20 feet on pipe lines exposed and concealed above accessible ceilings.
- Adjacent to all special fittings (regulating valves, etc.) in piping systems.
- At every access door.

D. Piping identification shall meet the standards of the Federal Occupational Safety Health Act (OSHA) which refers to the ANSI Standard A13.1. The following standardized color code scheme shall be used:

Yellow	- Hazardous Materials
Green	- Liquid Materials of Inherently Low Hazard
Blue	- Gaseous Materials of Inherently Low Hazard
Red	- Fire Protection Materials

E. The size of letter and length of color field shall conform to the ANSI standard and shall be as follows:

Outside Diameter of Pipe or Covering	Length of Color Field	Size of Letters
------ to 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
2-1/2" to 6"	12"	1-1/4"
8" to 10"	24"	2-1/2"
Over 10"	32"	3-1/2"

F. All pipe labels exposed within mechanical equipment spaces shall be semi-rigid plastic identification markers. Each label shall have appropriately color-coded background with printed legend. Directional flow arrows shall be included on label. Labels shall "snap-on" around pipe without the requirement for adhesive or bonding of piping sizes 3/4" through 5". Labels for piping 6" and larger shall be furnished with spring attachment at each end of label. Labels shall be "SETMARK" Type SNA, 3/4" through 5" size and Type STR, 6" and larger, as manufactured by Seton Name Plate Corporation, Brady, or equivalent.

G. All pipe labels except pipe labels located exposed within the mechanical equipment spaces shall be vinyl material with permanent adhesive for application to clear dry pipe and/or insulation jacketing. Each label shall have appropriate color-coded background with printed legend. Direction arrows shall be placed next to label to indicate flow direction. Color and size of arrows shall correspond to that of label. Pressure sensitive pipe tape matching the background color of the label shall be placed over each end of the label and completely around the pipe.

H. Attach pipe markers to lower quarter of the pipe on horizontal runs and on the centerline of vertical piping where view is not obstructed. Flow indicator arrow shall point away from pipe marker.

I. Provide the following labels, with ANSI/OSHA color for all piping systems as shown on the drawings and as listed below:

Service/Legend	Letter Color	Background Color
Domestic Cold Water	White	Green
Domestic Hot Water	Black	Yellow
Domestic Hot Water Return	Black	Yellow
Industrial (non potable) Cold Water	White	Green
Compressed Air	White	Blue
Roof Drain	White	Green
Sanitary Sewer	White	Green
Storm Sewer	White	Green

2.9 IDENTIFICATION OF CONTROL SYSTEM DEVICES

A. All automatic controls, control panels, zone valves, pressure electric, electric pressure switches, relays and starters shall be clearly tagged and identified. Wording shall be identical to that on the control diagram in the contract drawings.

2.10 UNDERGROUND PIPING SYSTEM IDENTIFICATION

A. Bury a continuous, preprinted, bright colored, plastic ribbon cable marker with each underground pipe regardless of whether encased. Locate directly over buried pipe, 6" to 8" below finished grade. Marker tape used in conjunction with buried plastic piping systems shall be special detector type. Marker tape used in conjunction with buried plastic piping systems shall be special detection type.

2.11 EQUIPMENT TAGS

A. Furnish and install equipment identification tags for all items of PLUMBING equipment furnished and installed under Division 22. Equipment tags shall be a minimum of 3/32" thick laminated phenolic plastic.

2.12 ACCESS DOORS

A. Provide all access doors required for access to valves, controls, or other items for which access is required for either operation or servicing. All costs incurred through failure to perform this function as the proper sequence of this work shall be borne by the Contractor. The type of access door shall be as required by the room finish schedule. Acoustical tile access doors shall be equal to Krueger Style B, Style A for acoustical plaster, Style C-CE for sidewall drywall or plaster construction, or Milcor institutional 10 gauge security/detention access door with welded joints, welded butt hinge, with detention type deadbolt lock and tamperproof screws.

B. Access doors shall be not less than 24" x 24" in size except that larger panels shall be furnished where required, and panels in tile or other similar patterned ceilings shall have dimensions corresponding to the tile or pattern module.

C. Where access doors are installed in walls required to have a specific fire rating, the access door installed shall be a fire rated access door with UL label, as manufactured by Milcor or equivalent. Access door in 1-hour construction shall be Class C and access doors in 2-hour construction shall be Class B.

PART 3 - EXECUTION

3.1 COOPERATION WITH OTHER TRADES

A. The Contractor shall refer to other parts of these specifications covering the work of other trades which must be carried on in conjunction with the plumbing work so that the construction operations can proceed without harm to the Owner from interference, delay, or absence of coordination. The Contractor shall be responsible for the size and accuracy of all openings.

3.2 DRAWINGS

A. The plumbing drawings show the general arrangement of all piping, fixtures, equipment, etc., and shall be followed as closely as actual building construction and work of other trades will permit. Whenever discrepancies occur between plans and specifications, the most stringent shall govern. All Contract Documents, including but not limited to Division 21 Fire Suppression, Division 23 HVAC, and Division 26 Electrical shall be considered as part of the work insofar as this information furnishes the Contractor with details relating to design and construction of the building. Architectural and Structural drawings shall take precedence over the plumbing, HVAC and fire suppression drawings. Install plumbing fixtures, floor drains, floor sinks, roof drains, etc. in locations as indicated on Architectural drawings. Because of the small scale of the plumbing, HVAC and fire suppression drawings, it is not possible to indicate all offsets, fittings and accessories which may be required. The Contractor shall investigate the structural and finish conditions affecting the work and shall arrange his work accordingly, providing such fittings, valves, and accessories as may be required to meet such conditions. Should conditions necessitate a rearrangement of piping, such departures and the reasons therefore shall be submitted by the Contractor for review in the form of detailed drawings showing the proposed changes. No such changes shall be made without the prior written approval. All changes shall be marked on the set of record drawings by the Contractor.

B. Should any doubt or question arise in respect to the true meaning of the drawings or specifications, the question shall be submitted in writing.

C. Installation of all plumbing equipment and piping systems shall be arranged to provide all clearances required for equipment operation, service, and maintenance, including minimum clearances required by applicable codes, manufacturer's installation instructions and as necessary for proper clearance in front of all electrical panels as defined by the National Electric Code (NEC). Piping systems shall not be routed through or above electrical equipment room or electrical equipment space designed within equipment rooms.

D. The Contractor's attention is directed to the unique architectural design features and consideration associated with this facility which will require significantly greater levels of coordination and cooperation for the work furnished and installed under Division 22 with the associated architectural, structural, and electrical work than is normally necessary for a more typical facility.

E. The installation of all concealed plumbing systems shall be carefully arranged to fit within the available space without interference with adjacent structural and electrical systems. The Contractor shall make all necessary provisions for penetrations of piping, including sleeves and blockouts in structural systems. The exact location of all exposed plumbing systems; access doors; piping exposed within finished areas; and other equipment and devices as applicable, shall be coordinated with the Architect, who shall have final authority for the acceptance of the work as it specifically relates to the architectural aesthetic design requirements for the facility. In no instance shall the building vapor barrier system be penetrated by the plumbing system installation without written approval.

3.3 FIELD MEASUREMENTS

A. The Contractor shall verify the dimensions and conditions governing his work at the building. No extra compensation shall be claimed or allowed on account of differences between actual dimensions, including dimensions of equipment, fixtures and materials furnished, and those indicated on the drawings. Contractor shall examine adjoining work, on which his work is dependent for perfect efficiency, and shall report any work which must be corrected. Coordination of all plumbing work within the building will be the direct responsibility of the Contractor. Review of submittal data in accordance with paragraph "Submittals" shall in no manner relieve the Contractor of responsibility for the proper installation of the plumbing work within the available space. Installation of equipment and systems within the building space shall be carefully coordinated by the Contractor with all building trades. Each contractor shall so harmonize his work with that of the several other trades that it may be installed in the most direct and workmanlike manner without hindering or handicapping the other trades. Piping interferences shall be handled by giving precedence to pipe lines which require a stated grade for proper operation. Sewer lines shall take precedence over water lines in determination of elevations. In all cases, lines requiring a stated grade for their proper operation shall have precedence over electrical conduit and ductwork. Installation of plumbing, HVAC and fire suppression equipment within the ceiling cavity shall be in the following order of priority: plumbing waste lines; roof drains; supply, return, outside air, makeup, and exhaust ductwork; fire sprinkler mains; fire sprinkler branch piping and sprinkler runouts; heating hot water and chilled water piping; domestic hot and cold water; control piping, wiring and conduit; miscellaneous special piping systems.

3.4 EQUIPMENT SUPPORT

A. Contractor shall provide support for equipment to the building structure. Contractor shall furnish all necessary structures, inserts, sleeves, and hanging devices for installation of mechanical and plumbing equipment, ductwork and piping, etc. Contractor shall completely coordinate installation of such devices with all trades and Sub-Contractors. Contractor must further verify that the devices and supports are adequate as intended and do not overload the building's structural components in any way.

3.5 SEISMIC SUPPORTS

A. The Contractor shall be responsible for all anchors and connections for the mechanical work to the building structure to prevent damage of equipment and systems due to earthquakes. The complete fire protection systems shall be supported as required to resist stresses produced by lateral forces as required by NFPA No. 13. Where mechanical equipment, piping, and ductwork is connected to the building structure, exact method and means of attachment to the structural system shall be approved by the Architect.

B. See Section 22 0548 for requirements for seismic supporting of plumbing equipment and systems.

3.6 PROTECTION OF MATERIALS AND EQUIPMENT

A. The Contractor shall be responsible for the protection of all work, materials and equipment furnished and installed under this section of the specifications, whether incorporated in the building or not.

B. Plumbing equipment and materials, including piping, valves and fittings, etc., shall be protected from damage and contamination. Equipment and materials shall not be stored outside and exposed to weather and ambient conditions without appropriate protection measures and without the approval of the Architect. Equipment and materials shall be delivered to the jobsite and maintained while on the jobsite with all openings, controls and control panels covered with caps, with heavy duty polyethylene wrap or other proper means. Equipment and materials where stored within the building shall be protected at all times from construction damage and contamination from dust, dirt, debris, and especially during fireproofing, painting and gypboard sanding and finishing. Unprotected equipment and piping will require special field cleaning by the Contractor prior to acceptance by the Architect.

C. The Contractor shall provide protection for all work where necessary and shall be responsible for all damage done to property, equipment and materials. Storage of materials within the building shall be approved by the Architect prior to such storage.

D. Pipe openings shall be closed with caps or plugs, or covered to prevent lodgment of dirt or trash during the course of installation. At the completion of the plumbing work, fixtures and materials shall be cleaned and polished thoroughly and delivered in a condition satisfactory to the Architect.

3.7 TRENCHING AND BACKFILLING

A. All excavation, trenching and backfilling required for the plumbing installation shall be provided by this Contractor.

3.8 MANUFACTURER'S INSTRUCTIONS

A. All equipment shall be installed in strict accordance with recommendations of the manufacturer. If such recommendations conflict with plans and specifications, the Contractor shall report such conflicts to the Architect, who shall make such compromises as he deems necessary and desirable.

3.9 CONCRETE BASES AND HOUSEKEEPING PADS

A. Concrete bases and housekeeping pads shall be installed under all pieces of plumbing equipment unless specifically deleted by the specifications or drawings.

B. Contractor shall be responsible for the accurate dimensions of all pads and bases and shall furnish and install all vibration isolators, anchor bolts, etc.

C. Contractor shall provide concrete housekeeping pad foundations for all floor mounted equipment installed under this section unless otherwise shown on the drawings. All concrete bases and housekeeping pads shall conform to the requirements specified under Division 3, Concrete, portions of these specifications. Pad foundations shall be 4" high minimum, unless otherwise indicated on the drawings. Chamfer edges shall be 1". Faces shall be free of voids and rubbed smooth with carborundum block after stripping forms. Tops shall be level. Provide dowel rods in floor for lateral stability and anchorage.

D. Equipment anchor bolts shall be set in a galvanized pipe or sheet metal sleeves 1" larger than bolt diameter. Anchor bolts shall be high strength steel J shape. Anchor bolt design shall be arranged and paid for by the Contractor.

E. Machinery bases, bed plates, sole plates, or vibration isolation units shall be carefully aligned, shimmed, leveled, then grouted in place with commercial non-shrink grout. When a flexible coupling is employed as a part of the drive train, the coupling shall be aligned before the machinery base is grouted.

3.10 EQUIPMENT FURNISHED UNDER OTHER SECTIONS OF THESE SPECIFICATIONS

A. Certain items of mechanical equipment as listed on the drawings and/or specifications will be furnished [under other sections of this specification for mechanical rough-in and connection under Division 22, including plumbing, domestic water and waste, cooling water, compressed air, etc. All required plumbing services, including connection of such services to equipment shall be provided under Division 22.

3.11 ALIGNMENT OF FLEXIBLE COUPLINGS

A. Flexible couplings between motors and driven equipment shall be aligned by the qualified service technician after the equipment is installed and ready for operation. Proper aligning shall be provided within manufacturer's maximum alignment tolerance at equipment operating conditions and temperature. Alignment shall follow unit manufacturer's written procedures using approved dial indication methods for parallel and angular alignment. The Contractor shall provide written certification that each device has been so aligned.

3.12 LUBRICATION

A. The Contractor shall provide all oil for the operation of all equipment until acceptance. The Contractor shall be held responsible for all damage to bearings while the equipment is being operated by him up to the date of acceptance of the equipment. The Contractor shall protect all bearings and shafts during installation and shall thoroughly grease the steel shafts to prevent corrosion. Bearings for items of plumbing equipment shall be marked at each bearing location as to whether the bearing is a sealed type or relubricable type unit.

3.13 PRESSURE RELIEF DEVICES

A. Pressure relief devices and fusible plugs shall be installed with piping to a safe location in accordance with Code requirements.

3.14 TESTS

A. Tests shall be conducted in the presence of the designated and authorized Owner's Representative. The Contractor shall notify the Architect a minimum of one week in advance of scheduled tests. Requirements for testing are specified under the sections covering the various systems. The Contractor shall furnish all necessary equipment, materials, and labor to perform the required tests.

3.15 INSTALLATION CHECK

A. An experienced, competent, and authorized representative of the equipment listed below shall visit the site of the work and inspect, check, adjust if necessary, and approve the equipment installation. In each case, the equipment supplier's representative shall be present when the equipment is placed in operation. The equipment supplier's representative shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation is approved and accepted.

B. Each equipment supplier's representative shall furnish a written report certifying that the equipment (1) has been properly installed and lubricated; (2) is in accurate alignment; (3) is free from any undue stress imposed by connecting piping or anchor bolts; and, (4) has been operated under full load conditions and that it has operated satisfactorily.

C. Equipment requiring installation check includes the following:

Domestic Water Heaters
Air Compressors/Dryers

3.16 OPERATION AND MAINTENANCE INSTRUCTIONS

A. The Contractor shall furnish complete operating and maintenance instructions covering all units of plumbing equipment fixtures, faucets, etc., herein specified together with parts lists. Equipment spare parts shall include all components requiring service, including motors, bearings, shafts, etc. A "Lubrication Chart" framed under Plexiglass shall be provided listing all types of oil to be used for each piece of equipment and the recommended frequency of lubrication. This chart shall be hung on the wall of the equipment room.

B. See Division 1 for additional requirements concerning manuals, manual distribution, and maintenance materials.

C. Operating and maintenance manuals as required herein shall be submitted for review and distribution to the Owner not less than two (2) weeks prior to the date scheduled for the Contractor to provide Operating and Maintenance Instructions to the Owner as specified herein.

D. Upon completion of all work and all tests, Contractor shall furnish the necessary skilled labor and helpers for operating the plumbing systems and equipment for a period of five (5) days of eight (8) hours each. During this period, the Contractor shall instruct the Owner or his representative fully in the operations, adjustment and maintenance of all equipment furnished. Contractor shall provide at least two weeks notice in advance of this period, with a written schedule of each training session, the subject of the session, the Contractors' representatives who plan to attend the session, and the time for each session.

E. Film the instruction and training sessions submit two copies of the DVD.

F. Operational test shall be conducted by the Contractor with the assistance of the equipment manufacturer's representative or service technician. Test shall be conducted in the presence of the designated and authorized Owner's Representative.

3.17 CERTIFICATIONS

A. Before receiving final payment, the Contractor shall certify in writing that all equipment furnished and all work done is in compliance with the contract documents and all applicable codes. Submit certifications and acceptance certificates, including proof of delivery of O&M manuals, spare parts required, and equipment warranties which shall be bound with O&M manuals.

3.18 CONSTRUCTION PHASING AND SCHEDULE

A. All work furnished and installed under Division 22 of this Specification shall be provided in accordance with the project schedule and phase requirements as described on the Architectural Drawings and Specifications.

3.19 PLUMBING SYSTEM SHUTDOWN AND REACTIVATION

A. The Contractor shall shutdown existing facility plumbing equipment and piping systems as required for installation of the project plumbing construction work. As a part of the required work, the Contractor shall drain down the existing systems and after completion of new work and pressure testing of systems, the Contractor shall refill the systems and re-establish proper system circulation, remove all air from piping system and equipment, and place system in full and proper operation.

3.20 SITE VISITS AND OBSERVATION OF CONSTRUCTION

A. The design professional shall make periodic visits to the project site at various stages of construction in order to observe the progress and quality of various aspects of the Contractor's work, in order to determine in general if such work is proceeding in accordance with the Contract Documents. This observation, however, shall in no way release the Contractor from his complete responsibility to supervise, direct, and control all construction work and activities. The design team has no authority over, or a responsibility to means, methods, techniques, sequences, or procedures of construction provided by the Contractor or for safety precautions and programs, or for failure by the Contractor to comply with all law, regulations, and codes.

B. Prior to the "Final" observation visit, the attached "Final Observation Checklist" shall be completed by the Contractor. Any non-applicable items shall be marked "N/A." The completed form shall be submitted, indicating that all necessary items are complete and requesting a final observation within 10 days. The Contractor shall be notified of any uncompleted items within seven (7) days. A resubmittal of the form and a new final observation request by the Contractor is required if the form is returned and noted as incomplete.

END OF SECTION 220500

Project:_____ **Date Submitted:**_____
General Contractor:_____ **Date of Final Mechanical System:**_____
Mechanical Contractor:_____ **Observation Requested:**_____

CONTRACTOR'S MECHANICAL & PLUMBING CHECK LIST
(ALL APPLICABLE ITEMS MUST BE COMPLETED PRIOR TO FINAL OBSERVATION)

In advance of requesting a final mechanical observation for installed mechanical systems, please check all items that have been completed. For all items not applicable to this project mark N/A.

HVAC/PIPING

_____1. All plumbing fixtures are set, sealed and cleaned.

_____2. All domestic pipe systems are insulated.

_____3. All pipe systems are identified with specified labels and directional arrows.

_____4. Floor sinks and drain grates are cleaned and debris removed.

_____5. Valve tags are installed.

_____6. Special equipment (water softeners, water heaters, piping systems, etc.) have been checked and put into service.

_____7. Medical gas systems have been checked and certified.

_____8. Special piping systems have been cleaned and pressure tested.

_____	Process Piping	_____	Nitrogen
_____	Compressed Air	_____	Vacuum
_____	Natural Gas	_____	Argon
_____	Other	_____	Medical Gas
		_____	Other

_____9. Limestone chips have been installed in acid dilution sumps.

_____10. Plumbing/piping connections have been completed to Owner furnished equipment and equipment furnished by other Contractors/Sub-Contractors.

_____11. Exterior wall hydrants have been cleaned.

_____12. Concrete collars have been installed at clean-out to grade, valve box, or other specified plumbing items.

_____13. Drains and relief lines from plumbing equipment have been installed and secured in a proper manner.

_____14. All plumbing equipment and areas of equipment have been cleaned and debris removed.

_____15. All plumbing equipment required by the Specifications has been identified and/or numbered.

_____16. Domestic water systems sterilization has been completed.

_____17. Strainers/suction diffusers have been cleaned.

_____18. Backflow preventers have been tested.

_____19. Air has been vented from all systems.

_____20. Ethylene glycol system has been charged with correct mixture and tested.

_____21. Water systems have been cleaned (X) and pressure tested (P).

_____	Non-potable Water	_____	Domestic Hot Water
_____	Domestic Cold Water	_____	Acid Waste and Vent
_____	Sanitary Sewer & Vent	_____	Roof and Overflow Drains
_____	Other (list)		

_____22. PRV's have been adjusted (water, gasses).

PLUMBING EQUIPMENT

_____1. All pump shafts and couplings have been aligned.

_____2. Boilers and domestic water heaters have been fired and tested.

_____3. All plumbing equipment has been lubricated.

_____4. Plumbing equipment has been labeled in accordance with the specifications.

_____5. "HAZARDOUS AREA" signs installed where applicable.

_____6. Variable frequency drives have been tested by the manufacturer's representative and certified to be in compliance with all of the specified requirements.

GENERAL ITEMS

The following specified items have been submitted:

_____1. Record drawings (to be submitted prior to final payment to the Contractor).

_____2. Operation and maintenance manuals.

_____3. Manufacturer's representative installation check and certification submitted (see list of equipment, Section 22 0500).

_____4. Test kits furnished to Owner.

_____ Flow Measuring Devices
_____ Flow Balance Valves
_____ Flow Control Devices

_____5. Control schematics and sequence of operation.

_____6. Plumbing equipment and lubrication, valve, charts have been provided to Owner's Representative.

END CHECKLIST

DIVISION 22 SUBSTITUTION REQUEST FORM (SRF)

TO: **BRIDGERS & PAXTON CONSULTING ENGINEERS, INC.**
PROJECT: _____

We hereby submit for your consideration the following product instead of the specified item for the above project:

Section: _____ Page: _____ Paragraph/Line: _____ Specified Item: _____

Proposed Substitution: _____

_____

Attach complete product description, drawings, photographs, performance and test data, and other information necessary for evaluation. Identify specific Model Numbers, finishes, options, etc.

1. Will changes be required to building design in order to properly install proposed substitutions? YES ☐ NO ☐
   If YES, explain: _____
2. Will the undersigned pay for changes to the building design, including engineering and drawing costs, caused by requested substitutions? YES ☐ NO ☐
3. List differences between proposed substitutions and specified item.

Specified Item	Proposed Substitution
_____	_____
_____	_____
_____	_____

4. Does substitution affect Drawing dimensions? YES ☐ NO ☐
5. What affect does substitution have on other trades? _____
   _____
6. Does the manufacturer's warranty for proposed substitution differ from that specified? YES ☐ NO ☐
   If YES, explain: _____
   _____
7. Will substitution affect progress schedule? YES ☐ NO ☐
   If YES, explain: _____
   _____
8. Will maintenance and service parts be locally available for substitution? YES ☐ NO ☐
   If YES, explain: _____
   _____
9. Does proposed product contain asbestos in any form? YES ☐ NO ☐

SUBMITTED BY: Firm: _____ Date: _____
Address: _____
Signature: _____ Telephone: _____

For Engineer's Use Only
Accepted _____ Not Accepted: _____ Received too Late: _____
By: _____ Date: _____
Remarks: _____

LICENSE AGREEMENT FOR CADD DATABASE OR BIM MODEL

PROJECT: _____

LICENSE GRANT: Contractor is granted use of the CADD Database or BIM Model (Database/Model) for the indicated project for the specific purpose of preparing submittal documents for this Project. No other use of the Database/Model is granted. Title to the Database/Model is not transferred to the Contractor. The Database/Model may be of value to the Contractor in preparing submittals, but use of the model does not relieve the contractor of the requirement to verify measurements in the field.

COPYING RESTRICTIONS: Contractor may copy the Database/Model in whole or in part, but only for backup and archival purposes or for use by the Contractor's Subcontractors. Contractor agrees to ensure that any entities that receive the Database/Model from Contractor, either in whole or in part, comply with the terms and conditions of this agreement. Contractor shall safeguard the Database/Model from falling into the hands of parties other than Subcontractors with a legitimate need for it.

WARRANTY: Bridgers & Paxton (B&P) offers this Database/Model without warranty and specifically without express or implied warranty of fitness. If Contractor chooses to use the Database/Model, then he does so at his own risk and without any liability or risk to B&P.

INDEMNITY: Contractor shall to the fullest extent permitted by law, defend, indemnify and hold harmless the Owner, Architect, B&P, their employees and agents from all claims, damages, losses, and attorney fees arising out of or resulting from the use of the Database/Model.

ACKNOWLEDGMENT: Contractor acknowledges that (s)he has read this Agreement, understands it, and agrees to be bound by its terms and conditions.

CONTRACTOR'S REPRESENTATIVE

Signature: _____ Company Name: _____

Name: _____ Address 1: _____

Title: _____ Address 2: _____

Date: _____

SECTION 220503 - TRENCHING AND BACKFILLING FOR PLUMBING

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and the General Requirements.

1.2 SCOPE OF WORK

A. The work in this section includes the furnishing of all labor, materials, equipment, transportation, hauling and services required in connection with the excavation, backfilling, compaction, grading and removal of earth from the site required for the installation of the mechanical work specified herein under Division 22.

1.3 SAFETY REGULATIONS

A. All work performed under this Section shall conform to the requirements of the General Conditions, Supplementary Conditions and Safety Requirements for this type of work.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3.1 TRENCHING AND BACKFILLING

A. General Excavation: The Contractor shall perform all excavation of every description and of whatever substances encountered, to the depths indicated on the drawings or as otherwise specified. During excavation, material suitable for backfilling shall be piled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading and to prevent slides or cave-ins. All excavated material not required or suitable for backfill shall be removed and wasted. Berming and grading shall be done as may be necessary to prevent surface water from flowing into trenches or other excavations, and any water accumulating therein shall be removed by pumping or by other approved methods. Sheeting and shoring shall be done as required for the protection of the work and for the safety of personnel.

B. Trench Excavation: Trenches shall be of adequate width for the proper laying of the pipe, and the banks shall be as nearly vertical as practicable and safe for workmen. The bottom of the trenches shall be accurately graded and bedded to provide uniform bearing and support for each section of the pipe at every point along its entire length. Bell holes and depressions for joints shall be dug after the trench bottom has been graded, and bedded in order that the pipe rests upon the prepared bottom for as nearly its full length as practicable. Care shall be taken not to excavate below the depths indicated. Where rock excavation is required, the rock shall be excavated to a minimum overdepth of 4 inches below the trench depths indicated on the drawings or specified. Overdepths in the rock and common excavation shall be backfilled with coarse sand, fine gravel, or otherwise suitable material. Whenever wet or otherwise unstable soil that is incapable of properly supporting the pipe is encountered in the bottom of the trench, such soil shall be removed to the depth required and the trench backfilled to the proper grade with coarse sand, fine gravel, or other suitable materials, as hereinafter specified.

C. The Contractor shall move trucks and equipment on prescribed roads and keep the roads free from mud, dirt and spillage.

D. If additional material is needed for fill on the project, it shall be furnished by the Contractor.

E. Bracing and Bulkheading: In all excavation work the Contractor shall provide necessary underpinning, bracing, or bulkheading to safeguard the work, the present structures, workmen, the public, and the property, and shall assume all responsibility in connection therewith.

F. Backfilling: The trenches shall not be backfilled until all required pressure tests are performed and until the utilities as installed conform to the requirements specified. The trenches shall be carefully backfilled with materials approved for backfilling; free from large clods of earth or stones. The entire depth of trench shall be backfilled in layers, and each layer shall be spread evenly, wetted to optimum moisture and thoroughly mixed to uniform consistency and compacted to the required maximum density obtainable as the same soil, as determined by ASTM D698.

G. All imported fill required under this section will be furnished by the Contractor. Imported fill will be base course material approved for use by the State Highway Department.

H. Fill material shall be free from trash, lumber or any type of debris which may be detrimental to producing the required density in the fill.

I. The earth beneath all sidewalks and concrete slabs shall be backfilled and compacted to at least 8" below any gravel or sub-base material before the placement of gravel or other base material and shall be coordinated with requirements contained within Division 2.

J. All piping not encased in concrete shall be bedded in sand or fine gravel, without rocks or other foreign material. Bedding material shall be placed around the pipe in accordance with manufacturer’s recommendations. The bedding material shall be distributed around pipe to assure full consolidation.

K. In grass and planted areas, the Contractor shall backfill his excavation to approximately 8" below finished grade. Contractor shall coordinate backfill requirements contained in Division 2.

L. The Contractor shall protect from damage all existing underground utilities indicated on the Contract Drawings or field located by underground utility locator service by the Owner prior to excavation operations. Any damage to such existing utilities shall be repaired by the Contractor without additional costs to the Owner.

M. Provide density test for trench, backfill in accordance with Division 2 requirements.

END OF SECTION 220503

SECTION 220504 - PIPE AND PIPE FITTINGS FOR PLUMBING

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

B. Lead Ban: All systems and system components, pipe, fittings, and fixtures delivering water for human consumption shall be lead free.

1. Any product designed for dispensing potable water shall meet both the NSF 61 and NSF 372 test standards via third-party testing and certification.
2. Lead free refers to <0.25% weighted average lead content in relation to wetted surface of pipe, fittings, and fixtures in systems delivering water for human consumption, and solder and flux which does not contain more than 0.2% lead.

1.2 RELATED SECTIONS

A. Section 22 0500, Common Work Requirements for Plumbing.

1.3 SUBMITTAL DATA

A. Contractor shall furnish complete submittal data for all piping materials, including manufacturer's specifications, certifications, class, type and schedule. Submittal data shall additionally be furnished for pipe hangers and supports, pipe sleeves including sealing and fire safing materials and installation.

PART 2 - PRODUCTS

See Division 23, Section 23 0504 – Pipe and Pipe Fittings, for applicable requirements.

PART 3 - EXECUTION

See Division 23, Section 23 0504 – Pipe and Pipe Fittings, for applicable requirements.

END OF SECTION 220504

SECTION 220505 - PIPING SPECIALTIES FOR PLUMBING

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Contractor shall furnish and install all piping specialties necessary for satisfactory operation of the systems. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

B. Lead Ban: All systems and system components, pipe, fittings, and fixtures delivering water for human consumption shall be lead free.

1. Any product designed for dispensing potable water shall meet both the NSF 61 and NSF 372 test standards via third-party testing and certification.
2. Lead free refers to <0.25% weighted average lead content in relation to wetted surface of pipe, fittings, and fixtures in systems delivering water for human consumption, and solder and flux which does not contain more than 0.2% lead.

1.2 RELATED SECTIONS

A. Section 22 0500, Common Work Requirements for Plumbing.

B. Section 22 0504, Pipe and Pipe Fittings for Plumbing.

C. Section 22 0523, Valves for Plumbing.

D. Section 22 0700, Plumbing Insulation.

E. Section 22 0549, Plumbing and Electrical Installation Coordination.

1.3 SUBMITTAL DATA

A. The Contractor shall furnish complete submittal data for all piping specialties including manufacturer's specifications, performance characteristics, ratings, installation instructions, certifications and approvals of listing agencies, wiring diagrams, and selection analysis.

PART 2 - PRODUCTS

See Division 23, Section 23 0505, Piping Specialties.

PART 3 - EXECUTION

See Division 23, Section 23 0505, Piping Specialties.

END OF SECTION 220505

SECTION 220523 - VALVES FOR PLUMBING

PART 1 - GENERAL

1.1 REQUIREMENTS

A. All Valves shall conform with current applicable provisions of the General Conditions, Supplemental General Conditions, and General Requirements.

B. All Valves shall meet the current MSS Specifications covering Bronze & Iron Valves. MSS-SP-80, MSS-SP-70, MSS-SP71, MSS-SP-85 where applicable.

C. Lead Ban: All systems and system components, pipe, fittings, and fixtures delivering water for human consumption shall be lead free.

1. Any product designed for dispensing potable water shall meet both the NSF 61 and NSF 372 test standards via third-party testing and certification.
2. Lead free refers to <0.25% weighted average lead content in relation to wetted surface of pipe, fittings, and fixtures in systems delivering water for human consumption, and solder and flux which does not contain more than 0.2% lead.

1.2 RELATED SECTIONS

A. Section 22 0500, Common Work Requirements for Plumbing.

B. Section 22 0504, Pipe and Pipe Fittings for Plumbing.

C. Division 21 for Fire Suppression System.

D. Division 22 for Plumbing.

1.3 SCOPE

A. Contractor shall furnish and install all valves and accessories necessary for satisfactory operation of the systems.

1.4 VALVE REQUIREMENTS

A. All Gate, Globe, Check, Ball valves shall be manufactured by Milwaukee, Nibco, Apollo, Stockham, Powell, Crane, Grinnell, or equivalent.

B. All lubricated plug valves shall be as manufactured by Rockwell, Walworth, Homestead, or equivalent.

C. Ball valves shall be utilized in lieu of gate valves and globe valves for all plumbing systems for sizes 2" and smaller.

D. All valves furnish under Division 22 and 23 of the same type shall be products of a single manufacturer unless otherwise approved by Owner's Representative.

E. Provide gate and globe valves with packing that can be replaced with the valve under full working pressure.

PART 2 - PRODUCTS

See Division 23, Section 23 0523 - Valves, for applicable requirements.

PART 3 - EXECUTION

See Division 23, Section 23 0523 - Valves, for applicable requirements.

END OF SECTION 220523

SECTION 220549 - PLUMBING AND ELECTRICAL INSTALLATION COORDINATION

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

1.2 RELATED DIVISIONS AND SECTIONS

A. Section 22 0500, Common Work Requirements for Plumbing.

B. Section 23 0900, Facility Management System.

C. Division 26 for Electrical.

D. Division 28 for Electronic Safety and Security.

1.3 SCOPE

A. It is the intention of this section to summarize the coordination of effort defined in the related sections and divisions of this specification.

B. If there is a conflict between this Section and other Sections and Divisions of this specification, this Section shall be the governing and decisive Section.

C. Make all connections to motors and controls for equipment supplied and/or installed under Division 22 according to Table 1 on the following page.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3.1 INSTALLATION

A. No work shall be performed until the reviewed and marked submittal data have been reissued to the Contractor, unless written permission is obtained from the Architect.

TABLE 1

Item or System	Note	Supplied By (3)	Installed By (3)	Powered By	Control Field Wiring By
Equipment Motors		Div. 22	Div. 22	Div. 26	N/A
Motor Control Center Including Starters, Pilot Lights, Heater, Switches, Auxiliary Contacts, and Internal Control Wiring		Div. 26	Div. 26	Div. 26	Div.23
Stand Alone Motor Starters (outside motor control centers)	(1)	Div. 26	Div. 26	Div. 26	Div. 23
Variable Frequency Drives (VFD's)		Div. 22	Div. 22	Div. 26	Div. 23
Fused and Non-Fused Disconnects	(1)	Div. 26	Div. 26	Div. 26	N/A
Control Relays & Control Transformers	(1)	Div. 22	Div. 22	Div. 26	Div. 23
Boilers & Domestic Water Heaters		Div. 22	Div. 22	Div. 26	Div. 23
Pressure Booster Pump Systems		Div. 22	Div. 22	Div. 26	Div. 23
Water Softeners & Other Process Water Equipment		Div. 22	Div. 22	Div. 26	N/A
Facility Management System (FMS) for Automatic Control and/or Monitoring of Plumbing System & Equipment	(2)	Div. 23	Div. 23	Div. 26	Div. 23
Medical Gas System - Alarm Panels, Sensors, Pressure Switches	(3)	Div. 22	Div. 22	Div. 26	Div. 22

TABLE NOTES:

1. Unless specified to be supplied with the equipment
2. Division 26 shall coordinate with Division 23, FMS Contractor as required to provide 120 VAC power to each mechanical space and the central plant as necessary for the FMS and as shown on the drawings. Any additional power, transformers, and distribution shall be provided by the Section or Division indicated.
3. Division 22 indicates the plumbing contractor or their designated representative including equipment suppliers, sub-contractors, etc.

END OF SECTION 220549

SECTION 220700 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

B. The Midwest Insulation Contractors Association and Industrial Insulation Standards, Latest Edition, shall be utilized as a standard for the work provided under this specification.

C. Materials shall conform to applicable ASTM standards.

1.2 RELATED SECTIONS

A. Section 22 0500, Common Work Requirements for Plumbing.

B. Section 22 0504, Pipe and Pipe Fittings for Plumbing.

1.3 SCOPE

A. All condensate pipe and fittings, domestic hot water pipe including circulating hot water, interior roof drains including roof drain bowls, interior overflow roof drains including overflow roof drain bowls, domestic cold water including non-potable water piping, water piping located outdoors exposed to ambient freezing conditions.

B. Equipment covering, including heat exchangers, storage tanks, pumps, domestic hot water boiler stacks and breeching, domestic water heater stacks and breeching.

C. Underground Piping Systems.

D. Plastic Piping Systems.

1.4 FITTINGS

A. All fittings except as otherwise specified, shall be insulated with the same material and thickness as specified for the pipe.

B. Unions, flanges and valves on hot water, will not require insulation.

1.5 TESTING

A. All piping shall be tested in accordance with the applicable Specification Sections, before any insulation is applied.

PART 2 - PRODUCTS

2.1 INSULATION

A. Insulation shall be as manufactured by Owens-Corning Fiberglas, Knauf, CertainTeed, Johns Manville, or Armstrong, or equivalent, and shall be equal to that specified below. Insulation and all materials on the interior and exterior surfaces of ducts, pipes, and equipment shall have a composite fire and smoke hazard rating not exceeding: Flame spread - 25; fuel contribution - 50; smoke developed - 50, as determined in accordance with ASTM Standard E-84. All insulation materials used for valves and fittings shall have the same ratings as the pipe insulation. Information must be submitted by means of manufacturer's literature showing that the proposed materials conform to above specification without exception.

B. Fiberglass pipe insulation shall be rigid molded and non-combustible with 'K' factor of 0.23 at 75^{o}F. Jacket shall be all service (ASJ) vapor barrier jacket with white kraft paper reinforced with glass fiber yarn and bonded to aluminum foil, secured with self sealing longitudinal laps and butt strips. Johns Manville 'Micro-Lok' or equivalent.

C. Hydros Calcium Silicate insulation shall be rigid molded, non-combustible per ASTME 136, conforming to ASTM 533, asbestos-free with 'K' factor of 0.40 at 300^{o}F., maximum service temperature 1200^{o}F., compression strength (block) minimum of 200 PSI to produce 5% compression at 1-1/2" thickness. Johns Manville 'Thermo-12 Gold' or equivalent.

D. Fiberglass rigid board insulation for equipment shall conform to ASTM C612 with 'K' factor of 0.23 at 75^{o}F, R=8.0 minimum, 3.0 pound per cubic foot density. Provide vapor barrier jacket (FSK) with aluminum foil reinforced with fiberglass yarn and laminated to fire-resistant kraft, secured with UL listed pressure sensitive tape and outward clinched expanded staples and vapor barrier mastic. Johns Manville 'Spin-Glas' or equivalent.

E. Elastomeric foam insulation for piping and equipment shall be flexible, cellular, molded or sheet, conforming to ASTM C534, with 'K' factor of 0.28 at 75^{o}F., maximum service temperature of 220^{o}F., maximum flame spread rating of 25 and maximum smoke development rating of 50 (3/4" thickness and less). Connections shall be made using manufacturer's approved waterproof vapor barrier retarder adhesive. Provide outdoor U.V. protective coating on all insulation exposed to ambient conditions.

2.2 FITTINGS

A. Valves and fittings, where required to be insulated, shall be covered with the same insulation material and thickness as specified for the pipe insulation and finished with PVC covers.

B. Valves and fittings with systems specified to be covered with metal or canvas, or polyvinyl chloride (PVC) jacket shall be covered with material to match piping system jacketing.

C. Polyvinyl chloride (PVC) preformed fitting covers with fiberglass inserts shall be used on valves and fittings, except where metal or canvas jacket is required for piping system. PVC fitting covers shall be Zeston 2000 or equivalent, gloss white and shall have a composite fire and smoke hazard rating not exceeding; flame spread - 25; smoke development - 50.

Connections shall be made using tacks and pressure sensitive color matching vinyl tape. Seams shall be on the bottom side of pipe and fittings.

2.3 METAL JACKETING

A. Metal jacket shall be 0.010-inch smooth Type 304 stainless steel, corrugated. Provide moisture barrier lining for service temperatures 60ºF and less, except where applied over insulation with All Service (ASJ) vapor barrier jacket. Stainless steel jacket shall be installed where specified herein or otherwise indicated on the drawings.

B. Metal jacket shall be 0.016-inch embossed aluminum. Provide moisture barrier lining for service temperatures 60ºF and less except where applied over insulation with All Service Jacket (ASJ) vapor barrier jacket. Aluminum jacketing shall be installed where specified herein or otherwise indicated on the drawings.

2.4 PVC JACKETING

A. PVC jacketing shall be Zeston 2000 or equivalent, gloss white, 0.020 inch thickness, minimum, and shall have a composite fire and smoke hazard rating not exceeding; flame spread -25; smoke development -50. Connection shall be made using tacks and pressure sensitive color matching vinyl tape. Seams shall be on the bottom side of pipe and fittings.

2.5 CANVAS JACKETING

A. Canvas jacketing shall be UL listed fabric, six ounce per square yard, plain weave cotton, treated with fire retardant lagging adhesive.

2.6 PIPE HANGERS AND SUPPORTS

A. See Specification Section 22 0504 for requirements associated with hangers and supports for piping systems.

B. All insulated piping systems shall be provided with individual hangers sized to encircle the insulation. Hangers for domestic cold water and roof drains may be installed under the insulation, provided that the vapor barrier system for cold piping and the hanger rods are protected from the formation of condensation by application of a heavy coating of vapor barrier mastic material.

C. Insulated piping supported by means of trapeze hangers or roller type hangers shall not rest directly on the hanger or support.

D. The insulation at hangers, trapezes and supports shall be protected by means of galvanized steel insulation half diameter support shields. Provide insulation insert between support shield and piping for piping size 1-1/2" and larger. Insulation inserts shall be heavy density calcium silicate molded insulation. Insulation inserts shall be the following minimum lengths. Factory fabricated thermal pipe shield as manufactured by Pipe Shields, Inc., and specified in Section 22 0504, may be used at Contractor's option.

Pipe Size, In.	Insert Length
1-1/2" to 2-1/2"	10" Long
3" to 6"	12" Long
8" to 10"	16" Long
12" and larger	22" Long

2.7 PIPE SLEEVES

A. See Specification Section 22 0504 for requirements associated with pipe sleeves for piping penetrations for building walls and frames.

B. Pipe sleeves shall be provided at penetrations through concrete and masonry construction and at fire rated and smoke rated walls and penetrations when required to comply with UL approved penetration assembly. Insulated piping passing through fire walls and smoke walls shall be provided with UL approved fire safing insulation to match the required insulation thickness and the space between the piping penetration and the adjacent wall construction shall be sealed air tight with UL approved fireproof caulking material. Pipe penetration arrangement and installation requirements shall match the applicable UL approved penetration assembly details.

PART 3 - EXECUTION

3.1 DOMESTIC HOT WATER PIPING

A. Domestic hot water pipingwith operating temperatures of 140^{o}F and less, including recirculating hot water piping shall be insulated with 1-inch thick fiberglass preformed pipe insulation with All Service Jacket (ASJ). Fittings shall be finished with PVC fitting covers.

B. Insulation thickness for domestic and service water systems operating in excess of 140^{o}F, shall be 1-inch thick fiberglass preformed pipe insulation with All Service Jacket (ASJ) for piping 3/4" through 3" size and 1-1/2" thick for piping 4" and larger. Fittings shall be finished with PVC fitting covers.

C. All voids formed by support saddles or other mounting or support hardware shall be filled with insulation.

3.2 DOMESTIC COLD WATER AND ROOF DRAINS

A. Domestic cold water piping and non-potable water piping shall be insulated with 1-inch thick fiberglass preformed pipe insulation with All Services Jacket (ASJ). Fittings shall be finished with PVC fitting covers. Cold water piping installed within interior partitions, not less than 10 feet from an exterior wall, and where no return air is present, need not be insulated.

B. Roof drain bowls and horizontal roof drain piping shall be insulated with 1-inch thick fiberglass insulation as specified for domestic cold water piping.

C. Overflow roof drain bowls and horizontal overflow roof drain piping shall be insulated with 1-inch thick fiberglass insulation as specified for domestic cold water piping.

D. All voids formed by support saddles or other mounting or support hardware shall be filled with insulation.

3.3 HANDICAP LAVATORY AND SINKS

A. Domestic hot and cold water piping and P-traps exposed below handicapped lavatories and sinks shall be insulated with HANDI LAV-GUARD insulation kits which satisfy ANSI A117.1 requirements. Insulation shall have a flexible vinyl finish which protects against burning and cushions impact.

B. Countertop sinks indicated within the Architectural drawings to be handicap-compliant shall have an off-centered drain opening and a maximum sink depth of 7-inches.

3.4 PLASTIC PIPING SYSTEMS

A. Plastic piping systems, including but not limited to polypropylene/CPVC, RO/DI piping, acid waste, vent piping and PVC piping, installed within building return air plenums shall be insulated with 1/2" thick fiberglass preformed pipe insulation with All Service Jacket (ASJ). Fittings shall be insulated with preformed insulation fittings or, where preformed fittings are unavailable, neatly insulated with fiberglass duct wrap with white vinyl jacket.

B. All voids formed by support saddles or other mounting or support hardware shall be filled with insulation.

3.5 METAL JACKETING

A. Metal jacketing shall be installed on all field insulated plumbing equipment and on plumbing piping systems exposed within the mechanical equipment spaces, that are installed exposed below 8 feet above the floor, where exposed to physical damage, on outdoor insulated piping, and where noted on the drawings.

B. The jacketing shall be applied with joints overlapped 2" and located to shed water. Joints and seams shall be caulked with an approved weatherproof caulking when located outdoors. The insulation shall be banded 12" on centers or screwed in place 3" on centers.

C. Fittings and valves shall have insulation covered with metal jacket, as specified herein. Fittings and valves on exterior piping and ductwork shall be covered with metal jacketing to match pipe and duct covers. PVC fitting covers, painted to match adjacent metal jacket, may be used on interior pipes and ducts.

3.6 PVC JACKETING

A. PVC jacketing shall be installed on all field insulated plumbing equipment and on all piping systems exposed within the mechanical equipment spaces, that are installed below 8 feet above the floor, where exposed to physical damage, and where noted on the drawings and specifications, except where metal or canvas jacketing is required.

B. Jacketing shall be secured in place in an approved manner by means of tacks and pressure sensitive tape.

C. Fittings and valves shall have insulation covered with PVC pre-molded PVC fittings to match jacketing, as specified below.

D. PVC jacketing shall not be permitted for use on exterior piping systems.

3.7 CANVAS JACKETING

A. Canvas jacketing shall be installed on all field insulated plumbing equipment and on all piping systems /exposed within the mechanical equipment spaces, and where noted on the drawings and specifications, except where metal or PVC jacketing is required.

B. Canvas jacket shall be adhered in place with fire retardant lagging adhesive and coating, to form a wrinkle free smooth continuous surface.

3.8 TERMINATION OF INSULATION

A. The termination of all insulation on pipes, at uninsulated valve connections, or unions, flexible connections, etc., shall be beveled and finished.

3.9 FACTORY INSULATED EQUIPMENT

A. Domestic water heaters and other equipment as specified in the equipment schedules on the drawings shall be factory insulated.

3.10 VICTAULIC COUPLINGS

A. Where Victaulic type couplings or similar piping systems are used, all couplings shall be insulated with insulation materials and thickness equal to the piping system. Insulation of couplings shall be as specified herein for fittings.

END OF SECTION 220700

SECTION 221100 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with the applicable provisions of the General Conditions, Supplemental General Conditions, and the General Requirements.

B. Lead Ban: All systems and system components, pipe, fittings, and fixtures delivering water for human consumption shall be lead free.

1. Any product designed for dispensing potable water shall meet both the NSF 61 and NSF 372 test standards via third-party testing and certification.
2. Lead free refers to <0.25% weighted average lead content in relation to wetted surface of pipe, fittings, and fixtures in systems delivering water for human consumption, and solder and flux which does not contain more than 0.2% lead. Solder shall be 95/5 tin antimony, alloy Sb5, conforming to FS QQ-S-571 and NSF 61.

1.2 RELATED SECTIONS

A. Section 22 0500, Common Work Requirements for Plumbing

B. Section 22 0504, Pipe and Pipe Fittings for Plumbing.

C. Section 22 0505, Piping Specialties for Plumbing.

D. Section 22 0523, Valves for Plumbing.

E. Section 22 0700, Plumbing Insulation.

F. Section 22 6801, Onsite Utilities, Plumbing.

G. Section 22 6801 and Division 33 for Outside Utilities.

1.3 SCOPE

A. A complete domestic cold water, hot water, recirculating hot water, non-potable water and make-up water system including water heaters, pumps, thermal expansion tank, meters, backflow protection, shock absorbers, and associated miscellaneous accessories. This section shall include all work within the building to a point approximately 5'-0" outside the building, or as otherwise indicated.

B. Coordinate with Division 33 for site utility drawings and specifications.

PART 2 - PRODUCTS

2.1 PIPING

A. Domestic water piping below grade or slab-on-grade shall be Type L soft copper, ASTM B88. Copper piping 2" and smaller shall be soft tubing and 2-1/2" thru 4" shall be either soft tubing or hard pipe. Domestic water piping 6" and larger below grade within the building and to a point approximately 5'-0" from the building shall be ductile iron pressure pipe, minimum 150 PSIG working pressure with mechanical joints. Wrap all underground copper pipe and fittings with minimum 20 mil polyethylene with minimum 50% overlay, provide for taping.

B. Domestic water piping including non-potable water piping above grade within the building 4" and smaller shall be Type L hard drawn copper, ASTM B88. Domestic water piping including non-potable water piping larger than 4" shall be either copper as specified herein or galvanized steel, ASTM A53 or A120, standard weight, Schedule 40.

C. Proper insulating fittings, as specified in Section 22 0504, shall be installed to prevent electrolytic action between steel and copper piping connections.

2.2 FITTINGS

A. Fittings for copper piping shall be wrought copper or cast brass conforming to ANSI B16.22 and B16.23, with 95-5 solder joints, as specified in Section 22 0504.

B. Mechanically formed tee connections and couplings for copper piping system as specified in Section 22 0504, may be utilized where approved.

C. Fittings for galvanized steel pipe shall be screwed Class 150, standard galvanized malleable iron conforming to ANSI B16.3 or Victaulic or equivalent mechanical pipe couplings as specified in Section 22 0505 and furnished with hot dipped galvanized coating for use with grooved piping system and approved for potable water systems.

D. Fittings for ductile iron pipe shall be flanged or mechanical joint conforming to ANSI/AWWA C110 and C111, Class 250 minimum, cement lined, with bituminous coating.

2.3 FLANGES

A. Flanges for copper piping systems shall be Class 150 wrought copper or cast brass conforming to ANSI B16.24.

B. Flange connections for valves and equipment shall match the rating and drilling of the valves and equipment furnished.

C. Flanges for galvanized steel piping system shall be galvanized cast or malleable iron Class 125, standard threaded plain face companion flanges for flanged connections in threaded piping systems.

D. Gaskets shall be 1/16" thick ring type or full face non-asbestos material suitable for the temperatures and pressure application.

E. Flange bolting shall be carbon steel machine bolts or studs and hex nuts, ASTM A307, Grade B.

2.4 JOINTS

A. Joints in copper piping system shall be made using approved "lead-free" solder and flux as described herein and approved by all applicable codes and regulations. Surfaces to be soldered shall be cleaned bright by manual or mechanical means.

B. All joints shall be properly fluxed with a non-corrosive "lead-free" type flux manufactured to approved standards, Federal Specification QQ-S-517. Joints for copper piping systems for cold water 3" and smaller and hot water 2" and smaller shall be made using composition 95-5 tin-antimony solder. Composition 15% silver solder shall be used for all other piping sizes and for all underground joints.

2.5 SHOCK ABSORBERS

A. Furnish and install factory sealed shock absorbers conforming to Federal Specification WW-P-541 at locations shown on the drawings and/or as outlined by Plumbing Drainage Institute Standard WH-201. Josam, Precision, Jay R. Smith, Wade, Watts, Zurn or equivalent.

2.6 DOMESTIC HOT WATER GENERATING EQUIPMENT

A. Water heaters and associated auxiliary equipment shall be as specified on the equipment schedule on the drawings. Natural gas fired or electric domestic water heaters shall be as manufactured by Bock, Bradford-White, Lochinvar, P.V.I., Ruud, Rheem, A.O. Smith, State, or equivalent.

B. Electric instantaneous water heaters shall be by Chronomite, Eemax, Hubbell, Keltech, Rheem, Stiebel Eltron, State, or equivalent.

C. Furnish and install approved expansion tank on cold water make-up supply to hot water generating equipment as recommended by manufacturer or as shown on the drawings and specified in the plumbing equipment and fixture schedule on the drawings, Amtrol, Wilkins, or approved equal.

D. The Contractor shall provide the services of a qualified factory-trained representative to supervise hot water generation system start-up and instruct the Owner’s operating personnel for a minimum of eight (8) hours. A full one (1) year service warranty, including all parts and labor, shall be provided by the Contractor.

E. Natural gas fired domestic hot water boilers and water heater combustion flues, stack, breeching, and combustion air louvers, ducts, etc., shall be provided under Division 23.

2.7 VALVES

A. Valves other than automatic control valves are specified in Section 22 0523, Valves.

B. Automatic control valves shall be as specified in Section 23 0900, Facility Management System, except for automatic control valves furnished as a part of equipment packages, including hot water generating equipment, as specified on the equipment schedule.

2.8 PUMPS

A. Pumps shall be of the type and capacity listed in the equipment schedule. Pumps shall be selected so that the motors will not overload under any operating condition. Furnish one spare mechanical seal of each size required in conjunction with the pumps furnished under this Contract. All base mounted pumps shall have drain pans with tapped pipe connections and 3/4" drain line extended to floor drain. Pumps shall be installed so that they may be removed without the removal of the associated piping. All pumps for potable water applications shall have bronze or stainless steel body and trim.

B. Domestic water inline re-circulating pumps shall be as specified on the drawings and as manufactured by Armstrong, Bell & Gossett, Taco, Thrush, or equivalent.

2.9 BACKFLOW PROTECTION

A. All cross-contamination control shall be provided to ensure that no installation of the potable water supply piping system shall be made in a manner that will allow used, unclean, polluted, or contaminated water or substances to enter the domestic potable water system.

B. All backflow devices and assemblies shall be approved by the applicable Administration Authorities and shall be installed according to all applicable codes, regulations, and manufacturer's instructions. Installation shall allow for required access and clearance for required testing, maintenance, and repair.

C. Reduced pressure backflow preventer assembly shall be furnished and installed by the Contractor. Backflow preventer size and arrangement shall be as indicated on the drawings, and shall be as manufactured by Febco, Hersey, Beeco, Watts, Wilkins, or equivalent. All costs, fees, and permits required shall be secured and paid for by the Contractor, unless otherwise indicated.

D. See Division 33 for backflow protection.

E. See Section 23 0504 for backflow preventer required for make-up water connections to HVAC systems.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Piping installation shall conform to the requirements of Section 22 0500, Common Work Requirements for Plumbing and Section 22 0504, Pipe and Pipe Fittings for Plumbing. Installation of specialties shall conform to the requirements of Section 22 0505, Piping Specialties for plumbing.

B. Insulating Fittings: Insulating unions shall be furnished and installed at all connections between dissimilar metals.

C. Valves: Each water service main, branch main and branch to a group of two or more fixtures shall be valved. Stop valves shall be as specified under fixtures.

D. Flexible Connections: If the Contractor uses a pipe material other than copper to connect to the City water main, provide mechanical joints at the connection point and also either a swing joint or expansion joint at a point 5 ft. outside the building to prevent failure of piping caused by differential settling of building and piping systems. The expansion joint material shall be suitable for domestic water usage and compatible with the sterilization chemicals.

3.2 STERILIZATION

A. All new water piping shall be charged with a chlorine solution containing not less than 50 PPM available chlorine. The solution shall remain in the piping for a period of 24 hours, during which time valves shall be opened and closed to permit a small flow of the solution. At the end of 24 hours, the solution shall be tested and must contain a residual of at least 5-10 PPM chlorine. The system shall then be drained and flushed to provide satisfactory potable water before final connection is made to the existing distribution system.

B. The Contractor shall submit a sample of the water, after sterilization and flushing for testing by an approved laboratory. A copy of the acceptable test report shall be submitted to the Architect prior to substantial completion.

3.3 BACKFLOW PROTECTION

A. Protection: All plumbing fixtures, faucets with hose connections, and all other equipment having plumbing connections shall have their water supplies protected against back-siphonage.

B. Testing: Arrange for testing backflow devices as required by the local health authorities.

3.4 TESTS

A. All water piping, hot and cold, shall be made tight under a hydrostatic test pressure of 150 lbs. per square inch and maintained without pressure loss for a minimum of four (4) hours. No caulking of joints will be permitted. Any joint found to leak under this test shall be broken, remade and a new test applied.

END OF SECTION 221100

SECTION 221123 - FACILITY NATURAL GAS SYSTEM

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions and Supplemental General Conditions.

1.2 RELATED SECTIONS

A. Section 22 0500, Common Work Requirements for Plumbing.

B. Section 22 0504, Pipe and Pipe Fittings for Plumbing.

C. Section 22 0505, Piping Specialties for Plumbing.

D. Section 22 0523, Valves for Plumbing.

E. Section 23 0900, Facility Management System.

F. Division 33 and Section 22-6801 for onsite utilities.

1.3 SCOPE

A. Complete building natural gas piping system including meters, regulators, and miscellaneous accessories. This section shall include all work within the building and to a point approximately 5'-0" outside the building, or as otherwise indicated.

PART 2 - PRODUCTS

2.1 PIPING

A. Above ground pipe used for the installation, extension, alteration, and/or repair of any gas piping system shall be black steel pipe ASTM A53 Grade A or B, ERW or BW, standard wall, Schedule 40.

B. All underground gas piping shall be steel or polyethylene plastic piping as specified in Section 22 0523, Valves for Plumbing. All underground steel piping and fittings shall be protected from corrosion by approved coatings or wrapping materials as specified in Section 22 0504, Pipe and Pipe Fittings for Plumbing, and Section 22 6801, Outside Utilities, Plumbing.

2.2 FITTINGS

A. Fittings for steel piping 2" and smaller shall be either screwed or welded. Screwed fittings shall be Class 150 standard black malleable iron conforming to ANSI B16.3. Weld fittings shall be either standard weight steel butt-weld fittings conforming to ANSI B16.9, or forged steel socket-weld fittings, 2000 pound Schedule 40 conforming to ANSI B16.11.

B. Fittings for steel piping 2-1/2" and larger shall be standard weight steel butt-weld fittings conforming to ANSI B16.9.

2.3 FLANGES

A. Flanges for steel piping system shall be forged steel, weld neck, or slip-on, 1/16" raised face Class 150 flanges conforming to ANSI B16.5.

B. Flange connections for valves and equipment shall match the rating and drilling of the valves and equipment furnished.

C. Where specifically required by the application, black cast iron Class 125 standard threaded plain face companion flanges may be utilized for flanged connections in threaded piping systems.

D. Gaskets shall be 1/16" thick full face non-asbestos material suitable for the temperatures and pressure application.

2.4 VALVES

A. Valves shall be as specified in Section 22 0523, Valves for Plumbing.

B. Valves used in conjunction with gas piping shall be approved for the required service.

2.5 GAS METERS

A. Natural gas meters shall be furnished and installed by the natural gas utility company, unless otherwise indicated on the drawings. All required permits and fees shall be secured and paid for by the Contractor in accordance with Section 22 0500. Gas meter shall be the type and capacity required for the application and shall be located as indicated on the drawings and in accordance with utility company requirements and applicable codes and ordinances.

B. See Division 22, Section 22 6801, for natural gas meters.

C. Natural gas sub-meters shall be furnished and installed by the Contractor in accordance with the information shown on the drawings and in the plumbing equipment and fixture schedule on the drawings.

D. See Section 23 0900, Facility Management System, for meters and instrumentation.

E. All natural gas meters shall be preceded by a main gas supply shut-off valve serviceable and accessible outside the building.

2.6 NATURAL GAS REGULATOR

A. Natural gas regulator shall be furnished and installed with the gas meter by the utility company, set for the required gas leaving pressure shown on the drawings.

B. Natural gas appliance and equipment regulators for all gas fired equipment furnished and installed under Division 23 and for natural gas fired equipment furnished by the Owner and/or under other sections of this specification shall be furnished by the equipment manufacturer or supplier and sized for the system inlet pressure and the required appliance operating pressure.

C. See Division 22, Section 22 6801,] for natural gas meter and regulator.

D. Natural gas regulators, as specified and shown on the drawings, shall be furnished and installed by the Contractor.

2.7 PIPING SUPPORTS

A. Natural gas piping installed on the building roof shall be supported by means of piping supports, especially designed to absorb thermal expansion and contraction of piping installed on built up and single ply membrane roofs. Wood blocks are not acceptable. Four inch and smaller gas piping shall be mounted on Erico Pyramid pipe supports or equivalent, pipe supports with a total weight not to exceed 100 pounds per pipe stand. Larger piping, and all piping requiring roller bearing action for pipe expansion, shall be mounted on Erico Pyramid RPS-H or equivalent, with a total weight not to exceed 1500 pounds per pipe collar support. Pipe support spacing shall be as recommended by manufacturer and as required by Code.

B. Piping hangers and supports shall be in accordance with Section 22 0504, Pipe and Pipe Fittings for Plumbing.

2.8 PAINTING

A. All natural gas piping installed outside the building exposed to the weather and/or exposed to view shall be field painted in accordance with the painting sections of this specification.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Piping installation shall conform to the requirements of Section 22 0500, Common Work Requirements for Plumbing, and Section 22 0504, Pipe and Pipe Fittings for Plumbing. Installation of specialties shall conform to the requirements of Section 22 0505, Piping Specialties for Plumbing.

B. Installation of piping and equipment shall be in accordance with applicable codes and regulations, including Uniform Plumbing Code and Uniform Mechanical Code, and NFPA No. 54, National Fuel Gas code.

C. No gas piping shall be installed in or on the ground under any building or structure, and all exposed gas piping shall be at least 6-inches above grade. Ferrous gas piping installed underground in exterior locations shall be protected for corrosion as specified herein and in Section 22 0504, Pipe and Pipe Fittings for Plumbing.

D. Gas piping supplying the building or facility shall be provided with a shut-off valve located outside the building and readily accessible. Where gas piping supplies multiple buildings or facilities, each building shall be provided with a shut-off valve as described herein.

3.2 EQUIPMENT AND APPLIANCE CONNECTIONS

A. All gas fired equipment and appliances shall be connected to the gas piping system in an approved manner and shall be furnished with a shut-off valve installed ahead of the unit. Connections shall in no case be less than the unit inlet connection size and shall be rigidly connected, except as otherwise shown on the drawings and allowed by codes and regulations.

3.3 DRIPS

A. Accessible capped drip pockets shall be furnished at low points in piping system, connections to appliances and equipment, and other locations where condensation may tend to collect.

3.4 VENTS

A. All gas regulators and other required devices installed within the building shall be vented to the outside of the building in accordance with manufacturer's requirements, codes, and regulations.

3.5 TESTS

A. All gas piping shall be pressure tested using air, CO2, or nitrogen in accordance with the applicable codes and regulations, including Uniform Plumbing and Mechanical Code as adopted and interpreted by the City of Lovington and State of New Mexico, and NFPA No. 54.

END OF SECTION 221123

SECTION 221316 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions and Special Provisions.

B. Furnish and install all concrete, grout, and other required materials to fill all blockouts and/or sleeves left open for this Contractor's convenience or for the installation of this work.

1.2 RELATED SECTIONS

A. Section 22 0500, Common Work Requirements for Plumbing.

B. Section 22 0504, Pipe and Pipe Fittings for Plumbing.

C. Section 22 0700, Plumbing Insulation.

D. Division 33 and Section 22 6801 for Onsite Utilities Plumbing.

E. Section 23 0900, Facility Management System.

1.3 SCOPE

A. Complete soil, waste, and vent system and associated miscellaneous accessories. This section shall include all work within the building to a point approximately 5'-0" outside the building, or as otherwise indicated.

B. Coordinate with Division 33 site utility drawings and specifications.

C. Plumbing equipment drains.

PART 2 - PRODUCTS

2.1 PIPING

A. Soil, waste, and vent piping below slab on grade shall be service weight cast iron no hub or bell and plain end pipe, coated inside and outside, conforming to ASTM A-74 and 87 Standards, or polyvinyl chloride (PVC) sewer pipe, Schedule 40, conforming to ASTM D3034. Cast iron pipe and fittings shall be used on all waste piping subject to waste water temperatures that exceed 120 degrees F.

B. Soil, waste, and vent piping above grade shall be either service weight cast iron no hub [or bell and plain end pipe, coated inside and outside, conforming to ASTM A-74 and 87 standards, or polyvinyl

chloride (PVC) sewer pipe, Schedule 40, conforming to ASTM D3034. At the Contractor's option or if specifically noted on the drawings, copper DWV pipe may be used. Vent piping 2" and smaller above grade may be Schedule 40 galvanized steel.

C. No-hub cast iron pipe shall conform to CISPI Standard 301 and shall be marked with CISPI Label.

2.2 FITTINGS

A. Fittings for cast iron sanitary soil, waste and vent piping system shall be service weight or no-hub cast iron drainage pattern conforming to ASTM C564. Fittings shall be provided to match the required piping system.

B. Fittings for galvanized steel vent system shall be galvanized malleable iron conforming to ANSI B16.4. Fittings for galvanized steel soil and waste piping shall be galvanized drainage pattern or Victaulic type galvanized ductile iron drainage pattern fittings for pumped systems with mechanical couplings as specified in Section 22 0504.

C. No-Hub pipe fittings shall comply with CISPI Standard 301 and shall be marked with CISPI Label.

D. Fittings for copper piping system shall be solder type drainage pattern conforming to ANSI B16.22 and B16.23.

E. Fittings for PVC piping system shall be Schedule 40 drainage pattern, solvent cement type conforming to ASTM B-2855 or elastomeric seal type conforming to ASTM D-3212.

2.3 JOINTS

A. Joints for cast iron pipe and fittings shall be suitable to match the required piping system and shall be either lead and oakum, double seal compression-type molded neoprene gaskets conforming to ASTM C-564 Standards, and suitable for the class of pipe being jointed, with adhesive type joint lubricant, Tyler "LUBRI/FAST" or equivalent. No-hub coupling shall be minimum four (4) band type with neoprene gasket material conforming to ASTM C-564, and 0.008-inch minimum, Type 304 stainless steel shear ring. Couplings shall be Tyler "Wide Body", Huskey Series 4000, Clamp-All, Mission Heavy Weight, Ideal, or equivalent.

B. Joints for galvanized steel shall be threaded, made with approved joint compound.

C. Joints for copper shall be soldered using 95-5 composition tin-antimony solder with non-corrosive flux.

D. Joints for PVC piping system shall be either solvent cement type conforming to ASTM D-2855 or elastomeric seal type conforming to ASTM D-3212, except all joints above grade shall be solvent cement.

2.4 PLUMBING EQUIPMENT DRAINS

A. Equipment drain lines shall be either Schedule 40 galvanized steel pipe with galvanized malleable iron fittings or Type L copper tubing with wrought solder fittings. Provide a dielectric union at all connections between ferrous to copper materials.

2.5 DRAINS

A. Floor drains, floor sinks, and interceptors shall be Josam, Rockford, Jay R. Smith, Wade, Watts, Zurn, Mifab, or equivalent, as specified on the drawings, and compatible with the required piping systems.

B. Non water-based trap seal maintenance devices by Jay R. Smith Mfg. Co., Liquidbreaker – The Green Drain, SureSeal, and TrapGuard as specified on the drawings are approved.

2.6 TRAPS AND TAILPIECES

A. Unless otherwise specified, traps shall be copper-alloy adjustable tube type with slip joint inlet and swivel, not less than 20 gauge and without cleanout. Inlets shall have rubber washer and copper alloy nuts for slip joints above the discharge level and swivel joints below the discharge level, metal to metal or metal to plastic type as required for the application. Outlet shall be threaded or socket for solder joint connection as required by the application. Tailpiece shall be copper-alloy to match P-trap. Furnish cast brass wall escutcheon at waste penetration through walls. P-traps, tailpieces, escutcheon, and all piping for above floor exposed installations, including installation within cabinets and casework shall be chrome plated. Underground P-traps shall be coated cast iron **or** plastic as required by the application.

B. Traps and associated trim shall be furnished by the plumbing fixture manufacturer as specified in Section 22 4000 and in the Fixture Schedule on the drawings, or shall be as manufactured by Dearborn, EBC, McGuire, T & S Brass, or equivalent.

2.7 CLEANOUTS

A. Cleanouts shall be as manufactured by Zurn, Jay R. Smith, Watts, Wade, or Josam, and shall be of the same size as the pipe, except that cleanout plugs larger than 4 inches will not be required. Cleanouts installed in connection with cast iron soil pipe shall consist of a long sweep, quarter-bend or one or two eighth bends extended to an easily accessible place, or as indicated on the drawings. A standard cleanout fitting, Zurn No. ZN-1400-ZB, with polished bronze top shall be caulked into the hub of the fitting and finished flush with the floor. Heavy duty cleanouts shall be Zurn Z-1474, with integral anchor flanges. Where cleanouts in connection with threaded pipe are shown and are accessible, they shall be cast iron drainage T-pattern, 90 degree branch fittings with square head brass screw plugs of the same size as the pipe up to and including 4 inches. Wall cleanouts in finished areas shall be Zurn No. Z-1460-8 with polished stainless steel or chrome plated metal cover.

B. Cleanouts for acid resistant piping system shall be compatible material for the required piping system.

C. Install cover flush with grade (outside) to avoid tripping hazard.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Piping installation shall conform to the requirements of Section 22 0500, Common Work Requirements for plumbing, and Section 22 0504, Pipe and Pipe Fittings for Plumbing. Installation of specialties shall conform to the requirements of Section 22 0505, Piping Specialties.

B. All soil, waste, and vent piping shall be properly graded and installed in strict accordance with all applicable codes and requirements.

C. Make all changes in direction of drainage piping by use of 45 degree wyes, long turn tee wyes, long sweep quarter bends, sixth, eighth or sixteenth bends. Short turn sanitary tees permissible on horizontal to vertical where space conditions require.

3.2 FLASHINGS

A. Flashing for piping through built-up roofing with lead flashing, weight of not less than four pounds per square foot, extending at least 12" in all directions under roofing and up pipe. Cap flash pipe and turn down inside 1" approximately. Run all pipes extending through roof prior to roof installation. Flashing shall be two-piece type, base and cap flashing.

B. Vinyl Flashing: As an option to lead flashing in vents through roof, the Contractor may use vinyl flashing, 20 mil thickness, ASTM C689-62 tear strength, 0.14 #/Ft. equal to Pasco Manufacturing Co., or equivalent. The flashing shall be installed in accordance with the manufacturer's recommendations.

C. Flash piping through the membrane roofing systems with premolded pipe seal elastomeric flashing and sealants that are compatible with EPDM single ply membrane. The flashing material and installation procedure shall be in accordance with the roofing manufacturer's recommendations.

3.3 DRAINS

A. All floor drains, trench drains, area drains, and floor sinks shall be installed with grates square with building lines and with the top of grates installed level with adjacent finished floor.

B. The Contractor shall extend drain lines from all equipment requiring drainage, relief valves, and drain pans to the nearest floor drain or floor sink, and shall terminate indirectly with a minimum clearance of one (1) inch or as otherwise required by applicable codes and standards. Relief valve drain lines shall be extended to the nearest floor drain and shall be equal in size to relief valve outlet port.

3.4 TESTS

A. The sanitary soil waste and vent system and condensate drain system shall be tested by filling system with water. System shall remain filled with no loss of water for a minimum of 2 hours. The system water test shall be applied to the drainage and vent systems either in its entirety or in sections. Preliminary testing shall be accomplished as necessary prior to final test.

B. If applied to the entire system, all openings in the piping shall be tightly closed, except the highest opening, and the system filled with water to point of overflow. If the system is tested in sections, each opening shall be tightly plugged except the highest opening of the section under test, and each section shall be filled with water, but no section shall be tested with less than ten (10) feet of water. In testing successive sections, at least the upper ten (10) feet of the next preceding section shall be tested, so that no joint or pipe in the building (except the uppermost ten feet) of the system shall have been submitted to a test of less than a ten (10) foot head of water. The system shall then be tight at all points.

END OF SECTION 221316

SECTION 221400 - FACILITY ROOF DRAINAGE

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with the applicable provisions of the General Conditions and Special Provisions.

1.2 RELATED SECTIONS

A. Section 22 0500, Common Work Requirements for Plumbing.

B. Section 22 0504, Pipe and Pipe Fittings for Plumbing.

C. Section 22 0700, Plumbing Insulation.

D. Division 33 and Section 22 6801 for onsite plumbing utilities.

1.3 SCOPE

A. A complete roof drainage and overflow roof drainage system and associated miscellaneous accessories. This section shall include all work within the building and to a point approximately 5'-0" outside the building, or as otherwise indicated.

B. Coordinate with Division 33 site utility drawings and specifications.

PART 2 - PRODUCTS

2.1 PIPING

A. Pipe, fittings and couplings below grade or slab-on-grade shall be service weight cast iron no hub [or bell and plain end] pipe, coated inside and outside, conforming to ASTM A-74 and 87 Standards, or polyvinyl chloride (PVC) sewer pipe Schedule 40, conforming to ASTM D3034.

B. Pipe, fittings and couplings above slab on grade shall be either service weight cast iron no hub or bell and plain end pipe, coated inside and outside, conforming to ASTM A-74 and 87 Standards, or polyvinyl chloride (PVC) sewer pipe Schedule 40, conforming to ASTM D3034.

C. No-hub cast iron pipe shall conform to CISPI Standard 301 and shall be marked with CISPI Label.

2.2 FITTINGS

A. Fittings for cast iron pipe shall be service weight or no-hub cast iron drainage pattern, conforming to ASTM C564, coated for underground installation.

B. Fittings for galvanized steel pipe shall be screwed galvanized cast iron or malleable iron drainage pattern or Victaulic type ductile iron drainage pattern fittings with mechanical couplings as specified in Section 22 0504.

C. Fittings for DWV copper piping shall be solder type copper or brass.

D. Fittings for PVC piping system shall be Schedule 40 drainage pattern, solvent cement type conforming to ASTM B-2855 or elastomeric seal type conforming to ASTM D-3212.

2.3 JOINTS

A. Joints for cast iron pipe and fittings shall be suitable to match the required piping system and shall be either lead and oakum, or double seal compression-type molded neoprene gaskets conforming to ASTM C-564 Standards, and suitable for the class of pipe being jointed, with adhesive type joint lubricant, Tyler "LUBRI/FAST" or equivalent. No-hub couplings shall be minimum four (4) band type with neoprene gasket material, conforming to ASTM 564, and 0.008-inch minimum, Type 304 stainless steel shear ring. Couplings shall be Tyler "Wide Body," Husky Series 4000, Clamp-All, Mission Heavy Weight, Ideal, or equivalent.

B. Joints for galvanized steel shall be threaded, made with approved joint compound.

C. Joints for copper shall be soldered using 95-5 composition tin-antimony solder with non-corrosive flux.

D. Joints for PVC piping system shall be either solvent cement type conforming to ASTM D-2855 or elastomeric seal type conforming to ASTM D-3212, except all joints above grade shall be solvent cement.

2.4 DRAINS

A. Roof drains and overflow roof drains shall be Froet, J. R. Smith, Josam, Mifab, Sioux Chief, Wade, Watts, Zurn, or equivalent as specified on the drawings and compatible with the required piping system. Drains shall be suitable for the required building construction system and shall be furnished complete with all extensions, receptors, flashings, and accessories required for the complete water-proof installation.

B. Catch basins shall be provided in accordance with the details and specifications shown on the drawings.

2.5 CLEANOUTS

A. Cleanouts shall be as manufactured by Froet, J. R. Smith, Josam, Mifab, Sioux Chief, Wade, Watts, Zurn, or equivalent, and shall be of the same size as the pipe, except that cleanout plugs larger than 4 inches will not be required. Cleanouts installed in connection with cast iron soil pipe shall consist of a long sweep, quarter-bend or one or two eighth bends extended to an easily accessible place, or as indicated on the drawings. A standard cleanout fitting, Zurn No. ZN-1400-ZB, with polished bronze top shall be caulked into the hub of the fitting and finished flush with the floor. Heavy duty cleanouts shall be Zurn Z-1474, with integral anchor flanges. Where cleanouts in connection with threaded pipe are shown and are accessible, they shall be cast iron drainage T-pattern, 90-degree branch fittings with square head brass screw plugs of the same size as the pipe up to and including 4 inches. Wall cleanouts in finished areas shall be Zurn No. Z-1460-8 with polished stainless steel or chrome plated metal cover.

2.6 ACCESSORIES

A. Refer to Section 22 1316, Sanitary Waste & Vent Piping, for roof flashing requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Piping installation shall conform to the requirements of Section 22 0500, Common Work Requirements for Plumbing, and Section 22 0504, Pipe and Pipe Fittings for plumbing. Installation of specialties shall conform to the requirements of Section 22 0505, Piping Specialties for Plumbing.

B. Roof drainage piping shall be properly graded and installed in strict accordance with all applicable codes and requirements. All turns and fittings shall be supported same as for waste and vent piping as specified in Section 22 1300.

3.2 PVC PIPING SYSTEMS

A. Installation of PVC piping systems within the building shall be in accordance with all applicable plumbing and building codes and ordinances. No exposed piping or fittings shall be installed within the building return air plenums unless the material complies with all code requirements, including required fire and smoke ratings, or is properly protected in a manner approved by the administration authority. Penetrations of fire rated barriers shall be provided with cast iron as specified in this section, or as otherwise approved and accepted by the applicable code authority. Piping above grade shall be installed with uniform slope and shall be properly supported to avoid sagging or bending of horizontal or vertical lines due to insufficient support or thermal expansion/contraction. All piping shall be supported and installed in strict accordance with manufacturer's recommendations.

B. PVC pipe and fittings exposed within building return air plenums shall be covered with an approved insulation material, as specified in Section 22 0700.

3.3 TESTS

A. The roof drainage system shall be tested by filling system with water. System shall remain filled with no loss of water for a minimum of 2 hours. The system water test shall be applied to the systems either in its entirety or in sections. Preliminary testing shall be accomplished as necessary prior to final test.

B. If applied to the entire system, all openings in the piping shall be tightly closed, except the highest opening, and the system filled with water to point of overflow. If the system is tested in sections, each opening shall be tightly plugged except the highest opening of the section under test, and each section shall be filled with water, but no section shall be tested with less than a ten (10) foot of water. In testing successive sections, at least the upper ten (10) feet of the next preceding section shall be tested, so that no joint or pipe in the building (except the uppermost ten feet) of the system shall have been submitted to a test of less than a ten (10) foot head of water. The system shall then be tight at all points.

END OF SECTION 221400

SECTION 221500 - COMPRESSED-AIR SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes

1. Pipe fittings, valves, and accessories
2. Filters
3. Automatic drain valves
4. Torpedo oil/water separators
5. Air dryers
6. Pressure regulating valves
7. Safety valves
8. Air compressors

1.2 SUBMITTALS

A. Submit the following in accordance with subcontract submittal procedures:

1. Manufacturer’s catalog data
2. Manufacturer’s installation instructions
3. Materials/Parts list
4. Operational and Maintenance data
5. Warranties
6. Certification of welders and qualified welding procedure per Section 01 4444 and 01 4455.
7. Welding Inspection Reports, as applicable.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum 5 years’ experience and having maintenance service based within 200 miles radius of installation.

B. Material and Installation: Conform to ASME B31.9, Building Services Piping for systems operating at pressure of 150 psig or less and at temperature of 200°F or less. For systems beyond above pressure and temperature limitations, conform to ASME B31.1, Power Piping unless supplying process air; then use B31.3. The design codes and pressure(s) for this installation are as follows: B31.3; 150 psig.

1.4 WARRANTIES

A. Provide a minimum of 1-year manufacturer's warranty, parts and labor, for air compressor system.

PART 2 - PRODUCTS

2.1 PRODUCT OPTIONS AND SUBSTITUTION

A. Alternate products may be accepted; follow Section 01 2500, Substitution Procedures.

2.2 COPPER TUBING AND FITTINGS (up to 2 inches)

A. Tubing: Copper, hard drawn or annealed, ASTM B88, Type L

B. Fittings: Wrought copper, ASME B16.22

C. Joints: Solder, ASTM B32, Alloy Sb5 tin-antimony

2.3 STEEL PIPE AND FITTINGS (over 2 inches)

A. Pipe: Black steel, ASTM A53, Schedule 40

B. Fittings: Steel, ASTM A234, Grade WPB, Schedule 40, butt-welding type, ASME B16.9

C. Joints: Welded

2.4 VALVES

A. Gate Valves: MSS SP-80 Class 150, bronze body, bronze trim, rising stem, handwheel, inside screw, solid wedge disc, solder ends to suit piping.

B. Ball Valves: MSS SP-110 Class 150, bronze, chrome-plated brass ball, full port, teflon seats and stuffing box ring, lever handle, solder or threaded ends to suit piping.

C. Globe Valve: MSS SP-80 Class 150, bronze body, bronze trim, solder or threaded ends to suit piping.

D. Swing Check Valve: MSS SP-80 Class 150, bronze body and cap, bronze swing disc with rubber seat, solder or threaded ends to suit piping.

2.5 STRAINER

A. "Y" type, Class 150, 20 mesh stainless steel perforated screen, bronze cast iron body, with blowoff gate valve and plug, solder or threaded ends to suit piping.

2.6 UNIONS AND FLANGES

A. Unions

1. Ferrous Pipe: ASME B16.39, Class 150, malleable iron, threaded unions.
2. Copper Tube and Pipe: ASME B16.22, Class 150, bronze unions with soldered joints.

B. Dielectric Unions

1. Union with galvanized or plated steel threaded end, copper solder end, water-impervious isolation barrier.

C. Flanges (N/A to copper)

1. Forged carbon steel, ASTM A105, Class 150

2.7 FLEXIBLE CONNECTOR

A. Manufacturer: Flex-Hose, Pumpsaver Connectors.

B. Braided bronze or stainless steel flexible connector with corrugated metal hose, minimum working pressure 200 psi at 70 degree F, minimum temperature rating 400 degree F, with solder or threaded ends to suit piping.

2.8 PREFILTER, HIGH-EFFICIENCY COALESCING

A. Manufacturers:

1. Van Air, Housing Series F200, Filter Grade C
2. Pneumatics Products, Housing Series P2001, Filter Grade SU

B. High-efficiency coalescing filter efficiency 99.99 percent at microns, maximum oil carryover 0.008 ppm by weight, maximum inlet temperature 125 degrees F, maximum clean dry pressure drop 1.50 psid. Housing maximum working pressure 250 psig at 225 degrees F, furnish with optional two-sided color-coded pressure differential indicator, and without internal float drain.

2.9 AFTERFILTER, HIGH-EFFICIENCY PARTICULATE

A. Manufacturers:

1. Van Air, Housing Series F200, Filter Grade RC

2. Pneumatics Products, Housing Series P2001, Filter Grade AF

B. High-efficiency particulate filter efficiency 99.99 percent at 0.9 microns, maximum inlet temperature 150 degrees F, maximum clean dry pressure drop 1.50 psid. Housing maximum working pressure 250 psig at 225 degrees F, furnish with optional two-sided color-coded pressure differential indicator, and without internal float drain.

2.10 AUTOMATIC DRAIN VALVE

A. Manufacturer: Van Air, Model EDV-2002

B. Solenoid valve, brass body, NEMA 4 enclosure, rated at 300 psig, open time 1 to 60 seconds cycle time 1-60 minutes, 6 foot power cord with plug, electrical 115V/ 1 PH/60 Hz, maximum fluid temperature 210 degrees F, ambient temperature range 32-150 degrees F.. Valve In/Out Port Size: 1/2 inch NPT

2.11 TORPEDO OIL/WATER SEPARATOR

A. Manufacturer: Eggelhof Inc., Albuquerque, 2 inch, Model 2 - 20 ABS. 4-inch diameter oil/water torpedo separator, ABS construction, 20 inch long. 2-inch diameter oil/water torpedo separator, ABS construction, 20 inch long. Furnish above with safety cable and 20 x 20 inch polypropylene absorbent pad.

2.12 PRESSURE GAUGE

A. Manufacturer: Ashcroft, Type 1009.

B. ASME B40.100, Grade 1A, minimum 2 1/2 inch dial, 1/4 inch NPT brass bottom connection, maximum plus or minus 1 percent full scale accuracy, stainless steel case, phosphor bronze bourdon tube, and isolation valve.

1. Range: 0-150 psi or as specified on drawings.
2. Cock Valve: 1/4 inch brass plug, 250 psi working pressure valve. Manufacturer: Anderson Metals, PAC-56NB, Part No. 138-00110.

2.13 PRESSURE REGULATING VALVE

A. Manufacturer: Watts, No. R119 Series

B. Reduced pressure type, range 0-125 psig, diaphragm operated, relieving spring adjustment mechanism, rated at 300 psig maximum, temperature range 40 - 120 degrees F.

2.14 DEW POINT TEST FITTING

A. Manufacturer: Hansen, No. GR-602. Brass quick-disconnect fitting, 1/4 inch FPT x QD.

2.15 MOISTURE INDICATOR

A. Manufacturers:

1. Van Air, No. 46-2300.
2. Pneumatic Products, Aquadex.

B. Visible moisture indicator assembly, with indicating silica gel that changes from blue to pink at dew point of 0 - 10 degrees F, & back to blue when dew point is lower than minus 10 degree F.

2.16 SAFETY VALVE

A. Manufacturer: Kunkle Model 6010.

B. Safety valve for air service, side outlet, full nozzle design, bronze body, brass and bronze trim, pressure range 15-250 psig, temperature range minus 60 to 406 degrees F, NPT ends, built and tested to ASME Section VIII, Division 1 Pressure Code, “UV” stamped.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install compressor unit on concrete housekeeping pad.

B. Install compressor unit on vibration isolators. Level and bolt in place. Refer to Section 22 0548, Vibration and Seismic Controls for Plumbing Piping and Equipment.

C. Route condensate drains to nearest floor drain.

D. Provide drain valves at low points of piping system.

E. Install take-offs to outlets from top of main, with shutoff valve after take-off. Slope take-off piping to outlets.

F. Install compressed air couplings, female quick connectors, and pressure gages as indicated on Drawings.

G. Labeling: Refer to Section 22 0554, Identification for Plumbing, HVAC, and Fire Piping and Equipment.

H. Pressure Testing: Refer to Section 22 0813, Testing Piping Systems.

I. Cap or seal ends of piping when not connected to mechanical equipment to ensure contamination by foreign material does not occur.

END OF SECTION 221500

SECTION 224000 - PLUMBING FIXTURES AND TRIM

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and the General Requirements.

B. Lead Ban: All systems and system components, pipe, fittings, and fixtures delivering water for human consumption shall be lead free.

1. Any product designed for dispensing potable water shall meet both the NSF 61 and NSF 372 test standards via third-party testing and certification.
2. Lead free refers to <0.25% weighted average lead content in relation to wetted surface of pipe, fittings, and fixtures in systems delivering water for human consumption, and solder and flux which does not contain more than 0.2% lead.

1.2 RELATED SECTIONS

A. Section 22 0500, Common Work Requirements for Plumbing.

B. Section 22 0504, Pipe and Pipe Fittings for Plumbing.

C. Section 22 1100, Domestic Water Piping.

D. Section 22 1316, Sanitary Waste and Vent Piping.

PART 2 - PRODUCTS

2.1 FIXTURES AND EQUIPMENT

A. Vitreous china and enameled cast iron fixtures by American Standard, Kohler, Sloan, Zurn, Mansfield, Toto, or equivalent as listed and described in the plumbing fixture schedule on the drawings. All vitreous china and enameled cast iron fixtures shall be white, unless otherwise indicated on the drawings. The material used for plumbing fixtures shall be of non-absorptive, acid-resistant vitreous china, enameled cast iron or stainless steel, and free from all imperfections. Each water service main, branch main, riser and branch to a group of fixtures shall be valved or as otherwise shown on the drawings to provide more stringent requirements. Stop valves shall be provided at each fixture. One piece chrome plated escutcheons shall be installed on all water piping and trap connections at walls or base cabinets. All exposed connecting piping and material shall be chrome plated.

B. Handicap accessible lavatories and counter mounted sinks shall have exposed supply and waste services insulated with rigid, molded insulation kits as manufactured by T.C.I. "Skal-Gard", Brocar "Trap Wrap", True-Bro "Handi Lav-Guard", McGuire "Prowrap", or equivalent. Provide off-set tail piece fittings on all handicap accessible laboratories and sinks as required.

C. Flush valves shall be low water consumption type as specified on drawings. Valves shall be diaphragm or piston type, with metal oscillating non-hold open handle, screw driver back check angle stop assembly with cap, adjustable tailpiece, vacuum breaker flush connection, and spud couplings as required for wall and fixture rough-in. Exposed flush valves shall be fully chrome plated, with chrome plated supply pipe cover. Furnish special trim for concealed installation with push-button and/or electronic sensor operation as specified in the Plumbing Fixture Schedule on the drawings. Electronic and battery operated flush valves shall be furnished with chrome plated metal cover. Flush valves shall be Delany, Sloan Royal, Sloan Regal, Zurn, American Standard, Toto, or equivalent.

D. Closet seats shall be furnished for water closets as specified on the Plumbing Fixture Schedule on the drawings. Closet seats shall be white unless otherwise required to match water closet. All closet seats shall be of smooth non-absorbent material and shall be properly sized for the water closet bowl type. All closet seats for fixtures for public use shall be open-front type without cover. Water closet seats provided for handicapped fixtures shall meet all handicapped requirements. Hinges, posts, nuts, and pintles shall be of a 300 series stainless steel construction. Water closet seats shall be furnished by the plumbing fixture manufacturer as specified on the Fixture Schedule on the drawings, or shall be as manufactured by Bemis, Beneke, Centoco, Church, Olsonite, Sperzel, or equivalent.

E. Floor mounted mop sinks and shower floors shall be as specified on the Plumbing Fixture Schedule on the drawings, molded stone or terrazzo, size and arrangement as shown on the drawings, as manufactured by Acorn, Centoco, Designer's Choice, Fiat, Mustee, Stern-Williams, Zurn, or equivalent.

F. Stainless steel sinks shall be as specified on the Plumbing Fixture Schedule on the drawings and as manufactured by Kohler, American Standard, Elkay, Just, Advance Tabco, Moen, Intersan, or equivalent. Countertop sinks indicated within the Architectural drawings to be handicap-compliant shall have an off-centered drain opening and a maximum sink depth of 7-inches. All sink basins shall have a center-rear outlet unless noted otherwise.

G. Electric water coolers (EWC) and drinking fountains shall be as specified on the Plumbing Fixture Schedule on the drawings and as manufactured by Acorn Aqua, Elkay, Guardian, Halsey, Haws, Murdock, Oasis, Sunroc, Taylor or equivalent.

H. Hose bibbs and wall hydrants shall be as specified on the Plumbing Fixture Schedule on the drawings and as manufactured by Zurn, Jay R. Smith, Wade, Woodford, Acorn, Chicago, T&S Brass, Watts, Prier, or equivalent. Handles, if specified shall be constructed of metal or brass and finished to match valve unit.

I. Shower valves and mixing valves shall be as specified on the Plumbing Fixture Schedule on the drawings, and as manufactured by Powers, Leonard, Lawler, Speakman, Symmons, Bradley, or equivalent.

J. Emergency fixtures including showers and eyewash shall be as specified on the Plumbing Fixture Schedule on the drawing and as manufactured by Bradley, Chicago, Haws, Speakman, Western, Guardian, Acorn Safety, or equivalent.

2.2 FAUCETS

A. Plumbing fixture faucets shall be brass construction and fully chrome plated, unless special finish is specified on the Plumbing Fixture Schedule on the drawings. Faucets shall be furnished complete with all accessories required for the necessary application, including aerators, handles, spouts, and operating cartridges. Contractor shall coordinate exact faucet requirements with required fixture drilling and water and waste rough-in. Faucets for handicapped fixtures shall meet all handicapped and ADA requirements, including a maximum of five (5) pounds of force to activate controls and adjustable metering faucet water flow duration of ten (10) seconds, minimum. Single hole faucets shall have anti-clocking pin to prevent rotation of valve body.

B. Plumbing fixture faucets shall be furnished by the fixture manufacturer as specified in the Plumbing Fixture Specification on the drawings and Paragraph 2.1 herein, or shall be as manufactured by Chicago, Delta, Moen, Speakman, T&S Brass, Zurn, or equivalent, and shall be commercial grade.

2.3 PLUMBING FIXTURE TRIM

A. Plumbing fixture trim including P-traps, supplies, and strainers shall be furnished by the fixture manufacturer as specified in the Plumbing Fixture Specification on the drawings and Paragraph 2.1 herein, or shall be as furnished by Chicago, Brass Craft, McGuire, T&S Brass, EBC, Zurn, or equivalent.

B. Unless otherwise specified, traps shall be copper-alloy adjustable tube-type with slip joint inlet and swivel, not less than 20 gauge and without cleanout. Inlets shall have rubber washer and copper alloy nuts for slip joints above the discharge level and swivel joints below the discharge level, metal-to-metal or metal-to-plastic type as required for the application. Outlet shall be threaded or socket for solder joint connection as required by the application. Tailpiece shall be copper-alloy, offset style, to match P-trap. Furnish brass or copper wall escutcheon at waste penetration through walls. P-traps, tailpieces, escutcheon, and all piping for above floor exposed installations, including installation within cabinets and casework shall be chrome plated.

C. Fixture supplies, strainers, and trim shall be brass construction. Supplies shall be commercial grade, quarter-turn all brass ball valves, plastic stems and handles are not acceptable. Furnish supply with loose key unless otherwise specified. Supply pipe shall be 3/8" O.D., with smooth (non-corrugated) flexible copper riser and wall escutcheon. Supply assembly shall be completely chrome plated for all exposed installations, including installation within cabinets and casework. Strainers and other miscellaneous fixture trim shall be furnished as required for the proper installation and shall be chrome plated to match faucets, unless special finish is required.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The Contractor shall provide all necessary supports and connection materials and trim for plumbing fixtures as required to assure a complete properly installed and operating system. Installation shall be in accordance with manufacturer's recommendations and with International Building Code and Uniform Plumbing Code requirements. The Contractor shall caulk fixtures to the adjacent wall, floor and countertop construction with non-shrink, mildew resistance caulking material.

B. Fixture mounting height shall conform to the ADA Accessibility Requirements and coordinated with the Architectural drawings.

1. ADA required Water Closet shall be mounted with top of seat 17” – 19” above finished floor.
2. ADA required Urinal shall be mounted at a maximum of 17” top of rim to finished floor.
3. ADA required Lavatory to be mounted with the rim or counter surface no higher than 34” above finished floor.
4. ADA required shower controls shall be located from 38” minimum to 48” maximum height above the shower floor.
5. ADA required Bathtub controls shall be located maximum of 48” above bottom of tub surface.
6. ADA required Sinks shall be mounted with counter or rim no higher than 34” above finished floor.
7. ADA required Drinking Fountains or Water Coolers spouts shall be no higher than 36” measured from the floor or ground surface to the spout outlet.

3.2 EQUIPMENT/FIXTURE SUPPORT

A. Furnish and install all "back-up" materials for fixtures and accessories, or as otherwise required by the equipment schedule to properly support and provide a sturdy installation.

3.3 FIXTURE CARRIERS

A. Fixture carriers shall be provided for all wall hung plumbing fixtures, including water closets, urinals, lavatories, sinks, etc., as manufactured by Josam, Jay R. Smith, Watts, Wade, Zurn, MiFab, or equivalent. Carriers shall be bolted to the floor using all of the support bolts recommended by the manufacturer. Where the water closet nipple and studs extend beyond the maximum carrier recommended length, provide additional carrier support as recommended by manufacturer. Water closet carriers shall be horizontal or vertical, single or back-to-back units as required for the fixture installation and piping arrangement, and shall be adjustable.

B. Single water closet carriers shall have factory installed rear hold down lugs and anchor foot to provide cantilever support.

C. Wall hung urinals shall be provided with floor mounted fixture carrier complete with upper and lower fixture support plates as required to match fixture installation requirements.

D. Wall hung lavatories and sinks shall be provided with floor mounted concealed arm type chair carriers, single or double (back-to-back) units as required for the fixture installation and arrangement.

E. Contractor shall be responsible to provide the proper arrangement and selection of fixture carriers required for fully concealed installation in the available plumbing chase and/or wall construction.

3.4 EQUIPMENT FURNISHED BY OTHERS

A. The Contractor shall furnish and install complete rough-in and connections, including stop valves on all supply piping for all mechanical services required for equipment furnished and installed under other sections of this specification, and for all owner-furnished equipment.

B. Types of equipment in this category shall include but not be limited to the following: kitchen equipment, shop equipment, hospital and laboratory casework, medical equipment, etc. The Contractor shall provide all pipe fittings, unions, traps, connecting wastes, valves, cocks, regulators, pressure reducing valves, flexible connectors, etc., as required for the services to each piece of equipment.

C. Installation and setting of equipment and fixtures furnished under other Sections of this Specification will not be provided under Division 22 of this Specification, unless otherwise indicated.

3.5 FIELD MEASUREMENTS AND COORDINATION

A. Exact location and rough-in requirements shall be carefully coordinated. Contractor shall refer to drawings and specifications, and shall check manufacturer's data, shop drawings and rough-in drawing submitted under Division 22 and other Divisions of this specification and make all field measurements to the extent necessary to ensure his understanding of the work required to provide for complete rough-in installation.

3.6 CLEANING

A. All fixtures shall be thoroughly cleaned before final acceptance of the work.

END OF SECTION 224000

SECTION 226801 - OUTSIDE UTILITIES

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with the applicable provisions of the General Conditions and Supplemental Conditions.

B. Lead Ban: All systems and system components, pipe, fittings, and fixtures delivering water for human consumption shall be lead free.

1. Any product designed for dispensing potable water shall meet both the NSF 61 and NSF 372 test standards via third-party testing and certification.
2. Lead free refers to <0.25% weighted average lead content in relation to wetted surface of pipe, fittings, and fixtures in systems delivering water for human consumption, and solder and flux which does not contain more than 0.2% lead.

C. Soldered joints below grade shall be made using Sil-Fos or Phos-Copper.

1.2 SCOPE

A. Natural Gas System.

1.3 RELATED SECTIONS

A. Section 22 0500, Common Work Requirements for Plumbing.

B. Section 22 0504, Pipe and Pipe Fittings for Plumbing.

C. Section 22 0505, Piping Specialties for Plumbing.

D. Section 22 0523, Valves for Plumbing.

E. Section 22 1100, Domestic Water Piping.

F. Section 22 1316, Sanitary Waste and Vent Piping.

G. Section 22 1400, Facility Roof Drainage.

H. Section 22 1123, Facility Natural Gas System.

1.4 GENERAL REQUIREMENTS

A. Excavation and backfilling shall conform to the requirements of Division 2 and Section 22 0503 on Excavation, Trenching, and Backfilling for Utilities. Work covered by this section will not be

accepted until backfilling connected with the work has been completed satisfactorily. Any section of the utilities that is found defective in material, alignment, grade, or joints before acceptance shall be corrected. All pipe and accessories shall be of new and unused material. The full length of each section of pipe shall rest solidly upon the pipe bed, with recesses excavated to accommodate the bells and joints. Any pipe that has the grade or joint disturbed after laying shall be taken up and relaid. The interior of the pipe shall be thoroughly cleaned of all foreign matter before being lowered into the trench and shall be kept clean during laying operations by means of plugs or other approved methods. The pipe shall not be laid in water, or when trench or weather conditions are unsuitable for the work. Water shall be kept out of the trench, until the joints are completed. When work is not in progress, open ends of pipe and fittings shall be securely closed so that no trench water, earth or other substance will enter the pipes or fittings. Any section of pipe found to be defective before or after laying shall be replaced with new pipe without additional expense to the Owner. Minimum depth of trench for water piping shall provide 42 inches of cover over the pipe. Minimum depth of trench for gas shall be 30 inches for plastic or 24" for steel.

1.5 UNDERGROUND PIPING IDENTIFICATION

A. The location of each underground piping system shall be marked using a continuous, pre-printed, colored plastic ribbon tracer tape, as specified in Section 22 0500. Additionally, non-metallic underground piping shall be provided with a special detection type tape conforming to applicable Code requirements.

PART 2 - PRODUCTS

2.1 NATURAL GAS SYSTEM

A. The gas distribution system is intended for the distribution of natural gas and the materials, appurtenances and workmanship used in this system shall be suitable and approved for natural gas service. Any section of the gas distribution system that is found defective in materials or workmanship before acceptance shall be corrected.

B. Plastic pipe welders shall be qualified in heat fusion techniques in accordance with Federal Standard 49 CFR, Part 192.285, and shall have in their possession evidence of such qualifications. Welders for steel piping shall be certified in accordance with the provision contained within Section 22 0500.

C. Contractor shall have a written procedure approved by the State of New Mexico for installation of polyethylene gas piping. Submit evidence of qualifications prior to commencing work on the natural gas piping system.

D. The gas system shall conform to the applicable requirements of all State of New Mexico codes and ordinances including the Uniform Plumbing Code, and Uniform Mechanical Code, NFPA No. 54, and to the rules and regulations of the Utility Company supplying the gas, including the U.S. Department of Transportation "Pipeline Safety Regulations, Part 192, CFR-49.

E. In shipping, delivering, and installing, pipe and accessories shall be handled in such manner as to ensure a sound, undamaged condition. Particular care shall be taken not to injure pipe and pipe coatings. No pipe or material of any kind shall be placed inside another pipe or fitting after the

coating has been applied. Coated and wrapped steel pipe shall be handled in conformance with the American Water Works Association Specification C204.

F. Submit manufacturer's catalog data and installation procedures on pipe, fittings, valves, risers and other material to be incorporated into construction for the natural gas distribution system.

G. Piping: Provide any of the following optional piping systems unless shown otherwise on the plans. All pipe and accessories shall be new and unused.

1. Polyethylene Plastic Pipe: Underground natural gas piping distribution system shall be black or yellow polyethylene plastic natural gas distribution pipe with heat fusion joints. Pipe shall be PE-2406, PE-3406, or PE-3408 in accordance with ASTM D2513, as manufactured by POLY-ARK, PLEXCO, Poly-Pipe or equivalent. Contractor shall use the same type and designation of piping throughout the project. Piping shall have approved tracing system (copper 18 gauge wire, or tape) and shall be installed in compliance with all requirements of Authority in jurisdiction.

    a. Risers: Anodeless risers shall consist of polyethylene encased steel pipe sweeps integrally connected to appropriately sized polyethylene pipe at the bury end with threaded IPS connections at the exposed end. Risers shall be as manufactured by Wayne or equivalent. Above ground piping and fittings used to connect to building services shall be black steel, Schedule 40, as specified in Division 23, Section 23 07 00. Incidental below-ground pipe and fittings shall conform to the above specifications and shall be coated and wrapped.
    b. Valves and Valve Boxes: Natural gas main valves shall be plastic valves of the size specified suitable for gas service, compatible with the polyethylene pipe utilized, and conforming to ANSI, Bl6.40, with a minimum working pressure of 125 PSIG, Rockwell or equivalent. Valves shall be installed in cast iron valve box and cover as specified under section for Water Systems, and shall be marked with "GAS" on cover.

2. Steel Pipe: Steel pipe used for the installation, extension, alteration, and/or repair of any gas piping system shall be black steel pipe ASTM 120 or A53 Grade A or B, ERW or BW, standard wall, Schedule 40. All underground steel pipe shall be coated and wrapped in accordance with AWWA C204 and Section 22 0504.
    a. Fittings: Fittings for steel piping 2" and smaller shall be either screwed or welded, except all underground piping system fittings and joints shall be welded. Screwed fittings shall be Class 150 standard black malleable iron conforming to ANSI B16.3. Weld fittings shall be either standard weight steel butt-weld fittings conforming to ANSI B16.9, or forged steel socket-weld fittings, 2000 pound Schedule 40 conforming to ANSI B16.11.
    b. Flanges: Flanges for steel piping system shall be forged steel, weld neck, or slip-on, 1/16" raised face Class 150 flanges conforming to ANSI B16.5. Flange connections for valves and equipment shall match the rating and drilling of the valves and equipment furnished. Gaskets shall be 1/16" thick full face non-asbestos material suitable for the temperatures and pressure application. Flange bolting shall be carbon steel machine bolts or studs and hex nuts, ASTM A307, Grade B.
    c. Valves and Valve Boxes: Valves shall be as specified in Section 23 0523, Valves and shall be approved for the required service. Valves shall be installed in cast iron valve box and cover, as specified under Section for Water Systems, and shall be marked with "GAS" on cover.

H. Gas Meters:

1. Natural gas meters shall be furnished and installed by the natural gas utility company, unless otherwise indicated on the drawings. All required permits and fees shall be secured and paid for by the Contractor in accordance with Section 22 0500, Common Work Requirements for Plumbing. Gas meter shall be the type of capacity required for the application and shall be located as indicated on the drawings and in accordance with utility company requirements and applicable codes and ordinances. All natural gas meters shall be preceded by a main gas supply shut-off valve serviceable and accessible outside the building.
2. See Division 22, Section 22 1123, Facility Natural Gas System for natural gas meters.
3. Natural gas meters shall be furnished and installed by the Contractor in accordance with the information shown on the drawings and in the plumbing equipment and fixture schedule on the drawings.
4. See Division 23, Section 23 0900, Facility Management Systems, for meters and instrumentation.

I. Natural Gas Regulator:

1. Natural gas regulator shall be furnished and installed with the gas meter by the utility company, and set for the required gas leaving pressure shown on the drawings.
2. See Division 22, Section 22 1123, Facility Natural Gas System for natural gas meter and regulator.
3. Natural gas regulators, as specified on the plumbing equipment and fixture schedule and as shown on the drawings, shall be furnished and installed by the Contractor.

PART 3 - EXECUTION

3.1 GENERAL

A. Install utility service lines to a point of connection to the building service lines, approximately five (5) feet outside of the building, and make connections to the building service lines in an approved manner. See the applicable specification sections for requirements associated with the building service lines. All non-metallic piping systems installed under this section of the specification shall terminate approximately five (5) feet from the building and piping system materials approved for installation within the building and specified in the applicable sections shall be provided for connection to the underground utility systems and extension to the building.

B. Installation of natural gas piping distribution systems shall be installed as specified herein and in strict accordance with manufacturer's recommendations.

C. In shipping, delivery, and installation pipe and accessories shall be handled in such manner as to ensure sound undamaged condition.

D. Cutting of pipe shall be done in a neat and workmanlike manner without damage to the pipe. Unless otherwise authorized. Cutting shall be done by means of an approved type of mechanical cutter. Wheel cutters shall be used whenever possible.

E. Where connections are made between new work and existing mains, the connections shall be made by using specials and fittings to suit the actual conditions. Standard methods are available for making connections to various types of pipe, either under pressure or in the dewatered condition.

F. Pipe passing through walls of vaults, pits, and structures shall be provided with ductile-iron or Schedule 40 steel wall sleeves. Annular space between walls and sleeves shall be filled with rich cement mortar. Annular space between pipe and sleeves shall be sealed in accordance with requirements contained in Section 22 0504.

3.2 INSTALLATION

A. Piping installation shall conform to the requirements of Section 22 0500, Common Work Requirements for Plumbing, and Section 22 0504, Pipe and Pipe Fittings for Plumbing. Installation of specialties shall conform to the requirements of Section 22 0505, Piping Specialties for Plumbing.

B. Installation of piping and equipment shall be in accordance with applicable codes and regulations, including Uniform Plumbing Code and Uniform Mechanical Code, and NFPA No. 54, National Fuel Gas Code.

C. Where the location of the water and sewer lines are not clearly defined in dimensions on the drawings, the water line shall not be laid closer horizontally than ten (10) feet from a sewer except where the bottom of the water line will be at least 12 inches above the top of the sewer line, in which case the water line shall not be laid closer horizontally than six (6) feet from the sewer. Where water lines cross under gravity-flow sewer lines, the sewer pipe for a distance of at least ten (10) feet each side of the crossing shall be fully encased in concrete or shall be made of pipe material approved for use within the building, with no joint located within three (3) feet horizontally of the crossing. Water lines shall in all cases cross above sewage force mains and shall be not less than two (2) feet above the sewer main. Joints in the sewer main, closer horizontally than three (3) feet to the crossing, shall be encased in concrete.

D. Water lines shall not be laid in the same trench with sewer lines, gas lines, fuel lines, or electric systems.

E. Copper tubing shall not be installed in the same trench with ferrous piping materials. Where copper tubing crosses any ferrous piping material, a minimum vertical separation of 12 inches must be maintained between pipes.

F. Where utility piping systems are required to be installed within three (3) feet of existing or new structures, the pipe shall be of a material approved for installation within the building or shall be installed within a sleeve of rigid conduit to a point 10'-0" on either side of the structure. Care shall be exercised and proper precautions taken during installation of the pipe and sleeve to assure that there will be no damage to the structure and no settlement or movement of foundations or footings. Any damage occurring as a result of the Contractor's operation shall be corrected and all costs connected therewith shall be borne by the Contractor.

3.3 JOINT DEFLECTION

A. Plastic Pipe: Maximum offset in alignment between adjacent pipe joints shall be as recommended by the manufacturer, but in no case shall it exceed five (5) degrees.

3.4 NATURAL GAS SYSTEM

A. Pipe Laying:

1. Lines may conform to the surface profile but should be graded as uniformly as practicable between pronounced high and low points. Pipe shall be laid on firm soil for the full length, and where the trench has been excavated below grade, either inadvertently or purposely, it shall be backfilled with suitable material and thoroughly tamped so as to provide full length bearing. Laying the pipe on blocks to produce uniform grade shall not be done. The pipe shall be clean inside before it is lowered in the trench and shall be maintained free of water, soil, and all other foreign matter that might injure or obstruct the operation of valves, regulators, burners, or other equipment. All openings to the pipe shall be closed by suitable means at all times except as the actual progress of the work may require. Stub ends and fittings installed for future connections shall be closed with plugs or caps. Minor change in line or grade of steel pipe, which can be accomplished through flexibility of the pipe without producing permanent deformation or overstressing the joints, may be made when approved. Changes in line or grade which exceed the limitations specified above shall be made with suitable fittings.
2. Install gas piping in separate trench with minimum horizontal clearance of thirty-six (36) inches from other utilities. Maintain twelve (12) inches vertical clearance at utility crossings. Maintain minimum cover to finish grade of 24 inches for steel or 30 inches for plastic piping. Snake plastic pipe laterally in trench to accommodate expansion and contraction of materials.

B. Jointing:

1. All joints in steel gas distribution system shall be made by the metal arc-welding process or oxyacetylene welding process in conformance with the American Standards Association Code B31.1, and in accordance with applicable requirements contained in Sections 22 0500 and 22 0504.
2. Joints for polyethylene natural gas piping distribution system shall be heat fusion welded or mechanical coupling installed in strict accordance with manufacturer's recommendations by qualified and certified plastic pipe installers. Foundation and bedding for plastic piping systems shall be in accordance with installation recommendations by the manufacturer.

C. Building Service Connections: Natural gas service connections to each individual building shall be made by means of an approved anodeless riser and steel pipe and fittings. All connections to buildings and service regulator piping shall be above ground, see Division 23, Section 22 1123.

3.5 TESTING OF NATURAL GAS

A. All gas piping shall be pressure tested using air, CO_2, or nitrogen in accordance with the applicable codes and regulations, including Uniform Plumbing and Mechanical Code as adopted and interpreted by the City of Lovington and State of New Mexico, and NFPA No. 54. Plastic piping shall be tested in accordance with 49 CFR, Part 192.513, except that these pressure shall be at least 60 PSIG.

B. All pipe joints in piping system shall be exposed until they are tested. Piping between joints may be backfilled prior to test.

3.6 COMMISSIONING SYSTEM

A. The Contractor shall furnish, install, and set all regulators based on capacity and pressure as shown on drawings. Provide a plugged tee for measuring downstream pressure from regulator. A U-tube water manometer shall be used to adjust the leaving pressure. Provide a record of the entering and leaving pressure for each regulator.

3.7 CLEANUP

A. Upon completion of the installation of all outside utilities, Contractor shall remove all surplus construction materials and debris resulting from the work.

END OF SECTION 226801

SECTION 230500 - COMMON WORK REQUIREMENTS FOR HVAC

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. See General Conditions and Supplemental General Conditions.

B. The requirements listed under General Conditions and Supplemental General Conditions and the General Requirements are applicable to this Section and all subsequent sections of this Division and form a part of the contract.

C. See Division 2, Site Work for additional requirements regarding Trenching, Backfilling for buried piping.

1.2 **DESIGN INTENT**

The mechanical HVAC system will be a combination of high efficiency packaged rooftop unit system and variable refrigerant flow (VRF) heat pump system.

Dorms & Officer's Quarters: HVAC system consists of a Variable Refrigerant Flow (VRF) heat pump system. VRF fan coil units are located above each space, and connected to a shared Heat Recovery/Heat Pump unit located on the roof or ground. Multiple Indoor fan coil units (evaporators) are connected to a single condensing unit. As a result, the refrigerant acts much like a condenser water loop in a water source heat pump system allowing some zones to share heat with others that demand it.

Ventilation air will be provided by a dedicated outside air handling unit. This unit will be a packaged heat recovery unit located in the ceiling plenum of the building. The heat recovery unit will use the general building exhaust air to pre-heat and cool the incoming outside air. The ventilation air will be ducted to the ceiling space of individual rooms served by the VRV ceiling mounted indoor units. The ventilation air will be mixed with air recirculated from the space.

The energy recovery unit will also circulate air out of the building at approximately the same rate as the ventilation air that is being delivered into the building. Exhaust air ductwork will extend down into the ceiling space and draw air from rooms normally requiring exhaust, as well as exhausting air from the ceiling plenum to approximately match the amount of ventilation air. Toilet rooms and janitor closets will be exhausted at a minimum rate of 16 air changes per hour. Smaller single occupant toilet rooms will be exhausted with small ceiling mounted exhaust fans vented directly up through the roof. These small ceiling exhaust fans will be interlocked to operate with the room light switch.

Commons & Living Room: The HVAC system will be packaged rooftop units. Each zone with be controlled served by a packaged roof top unit. The packaged units will consist of a constant volume supply fan, DX refrigerant cooling coil, and gas fired heat exchanger. Additionally, the packaged units will include, filters and an air side economizer for free cooling when ambient outside temperatures permit. When conditions are ideal for free cooling, dampers in the unit will draw 100% outside air through the unit and deliver it to the space. During the economizer operation, the unit will draw 100% outside air and relief air from the building. This will be accomplished with a barometric relief damper

within the roof top unit that allows air to exit the unit. Additionally, the outside damper within the unit will have a minimum position that allows minimum outside air to be circulated into the building for ventilation. The minimum outside air will be delivered to the space regardless of economizer operation. These units will be provided with a factory mounted and wired control systems. Low pressure ducts will be extended to ceiling supply diffusers or, sidewall registers within each space.

Electrical and Data Rooms: These rooms will be conditioned with dedicated DX heat pump units located in each room. A dedicated condensing unit will be located on the roof for each indoor heat pump.

Kitchen Area: A rooftop exhaust fan and grease hood will be specified. Make-up air for the kitchen hood will be provided by the rooftop unit serving the Dayroom and Dining area.

Apparatus Bays: Apparatus Bays HVAC system consist of gas fired unit heaters. A dedicated exhaust system with roof mounted exhaust fans and air intake hoods with wall switch will be provided for general exhaust. A Plymovent vehicle exhaust system will be provided to remove tailpipe carbon monoxide exhaust from each bay.

Automatic Temperature Controls: Control / Monitoring systems for the building's mechanical components will utilize a computer-based energy management system. This can include remote monitoring capability and alarming of building equipment, temperature and pressure relationships where needed. Website type access can be provided for remote access. A graphic representation of each mechanical system will be displayed at a computer work station or laptop. The controls / monitoring system will be integrated with the packaged controls for each type of equipment noted above.

1.3 INDEX OF SPEC SECTIONS FOR THIS DIVISION

23 0500	Common Work Requirements for HVAC
23 0504	Pipe and Pipe Fittings
23 0505	Piping Specialties
23 0523	Valves
23 0548	Vibration and Seismic Controls for HVAC
23 0549	HVAC and Electrical Installation Coordination
23 0593	Testing, Adjusting and Balancing of Mechanical Systems
23 0700	Mechanical Systems Insulation
23 0900	Facility Management System for DDC Controls
23 2313	Refrigerant Piping System and Equipment
23 3000	Air Tempering System and Equipment
23 3813	Kitchen Exhaust and Makeup Air Systems
23 7413	Packaged Outdoor Central Station Air Handling Units
23 8126	Variable Refrigerant Flow (VRF) Air Conditioning – Three Pipe Heat Recovery

1.4 DEFINITIONS

A. General: Terms will have meanings as defined in Webster's Eleventh New Collegiate Dictionary except as noted below.

B. Entities

1. Owner: Lovington Fire Department

2. Architect: WDG Architects-Williams Design Group Inc
3. Engineer: Bridgers & Paxton
4. Owner's Representative: The Owner will designate his representative after bid. The abbreviation “OR” may be used throughout these specifications to refer to the Owner’s Representative.
5. Owner's Agents: The Architect, Engineer, and others authorized to act on behalf of the Owner.

C. Actions

1. Supply: Procure and deliver to the site with all features as specified, required per code, and as required for proper installation. Include submittals, O&M manuals, operator instructions, and warranty.
2. Install: Set in place in accordance with manufacturer's instructions, contract documents, and applicable codes and standards. Coordinate the installation with other disciplines, start, and demonstrate proper operation.
3. Furnish: Supply and install.
4. Provide: Supply and install.
5. Accepted: By the Owner’s Representative except as noted.
6. Approved: By the Owner’s Representative except as noted.
7. Review: By the Engineer except as noted.

D. Locations

1. Buried: Surrounded by soil or other material, either beneath the building or exterior to the building.
2. Exterior: Exposed to rain or snow. Examples include rooftop locations, spaces around cooling towers, pipe racks, etc.
3. Interior: Not exterior or buried. Examples include not only spaces within the heated envelope of the building, but also unheated attics, covered loading docks in which spaces are protected from rain and snow, utility tunnels, sheds, etc.
4. Finished Spaces: Interior spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated attics, spaces above ceilings, crawlspaces, and tunnels.
5. Exposed: Exposed to view. Examples include finished spaces mechanical equipment rooms, rooftops, etc.
6. Concealed: Not Exposed.

E. Other Definitions:

1. 24/7: 24 Hr/day, 7 days per week, year-round.
2. AHJ: Authorities having jurisdiction. The authorities having jurisdiction over this project are established by statute, and include governmentally designated building departments, the fire marshal, fire departments, etc. No attempt is made to list all such entities here; a qualified Contractor is expected to know and coordinate with the various authorities having jurisdiction.
3. FMS: Facility Management System
4. Local: Based no further from the job site than the Engineer is. For example, where the specifications call for a local factory authorized service agent, then on a daily basis that agent must be based in an office or warehouse located no further from the project site than the Engineer’s office.

5. OAE: Or approved equal.

1.5 CODES AND PERMITS

A. Perform all work in accordance with the 2015 International Building Code, the 2012 Uniform Plumbing Code, and the 2012 Uniform Mechanical Code, as adopted and interpreted by the State of New Mexico and City of Lovington and the National Fire Protection Association (NFPA Regulations), current adopted edition. Provide all materials and labor necessary to comply with rules, regulations and ordinances. Where the drawings and/or specifications indicate materials or construction in excess of code requirements, the drawings and/or specifications shall govern. Contractor shall hold and save the Owner and his agents free and harmless from liability of any nature or kind arising from the Contractor's failure to comply with codes and ordinances.

B. Secure and pay for all permits necessary for performance of the work, including utility connections, extensions, meter pits and meter sets and tap fees for water, storm sewer, sanitary sewer and natural gas, unless otherwise specified herein.

C. Comply with the requirements of, and the recommendations of:

1. Applicable county and state mechanical, electrical, gas, plumbing, health and sanitary codes, laws and ordinances
2. National Electrical Manufacturer's Association
3. National Electrical Code
4. Underwriters Laboratories
5. American National Standards Institute
6. American Society for Testing Materials
7. Local utility companies
8. National Fire Protection Association
9. ASME Boiler and Pressure Vessel Codes
10. Occupational Safety and Health Administration
11. International Fire Code
12. Midwest Insulation Contractors' Association (MICA)
13. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
14. American Society of Sanitary Engineering
15. American Gas Association

1.6 PRIOR APPROVAL

A. See Division 1 for prior approval requirements.

B. Equipment manufacturers and service providers are listed within the specifications for the work specified in this division. For the items listed below, the specified manufacturers and providers are the only ones presently approved, and may be the only ones allowed:

Air Handling Units and Air Conditioning Units
Carbon Monoxide Exhaust System
Facility Management System

C. Manufacturers and service providers who are not listed in these specs, and who offer equivalent or superior products or services, are invited to submit for approval prior to bid (prior approval). Submit two copies. Requests for prior approval must:

1. Include the substitution request form at the end of this spec section.
2. Include technical data sufficient for the Engineer to generally assess appropriateness for this project.
3. Be submitted minimum ten days prior to the bid date in effect at the time of submission.
4. Comply with any additional requirements per specification Division 1.

D. Any additional prior approved alternate manufacturers and service providers will be published in an addendum prior to bid. Prior approval indicates that based on the information submitted it appears to the Engineer that the alternate might be capable of meeting the specifications and the design intent, and might be appropriate for the project. But prior approval does not guarantee this. Prior approved products and service providers must still go through the submittal process after award, and must still comply with the design intent and all specification requirements.

E. Please do not request prior approval for products and service providers that are not listed above. Instead, for those items alternate manufacturers and alternate service providers may be submitted after bid in accordance with the submittal process, provided they meet or exceed the specifications and the indicated design intent.

1.7 DOCUMENT MANAGEMENT

A. Contractor is encouraged to use a web-based document management system for RFIs and submittals. If used, Contractor shall provide and pay for licenses and training for the engineer's project personnel. The section below describes procedures for handling submittals if a web-based document management system is not used. If a web-based system is used, the procedures below shall be modified as appropriate.

1.8 SUBMITTALS

A. See Division 1 and individual specification sections within this division for additional submittal requirements.

B. Schedule: Submit all submittals in a timely manner consistent with the requirements for completing the work covered by this contract within the prescribed contract time. Be aware that there is risk in ordering components, fabricating work, and/or installing work prior to review. If the Contractor proceeds prior to review, and then the review comments required modifications to work which has begun or has been completed, then Contractor must comply with the review comments at no change in contract amount or schedule.

C. Shop Drawings

1. Submit shop drawings for

a. Mechanical equipment rooms and other spaces housing air handling equipment, heat transfer equipment, fluid handling equipment, machinery, etc.

b. Complete supply, return, and exhaust ductwork systems, both exposed and concealed.
c. Piping for HVAC, plumbing, medical gas, and fire protection systems, both exposed and concealed.

2. Show the location and elevation of all equipment, ductwork and piping, as well as openings through slabs and walls. Include plans, elevations and sections as appropriate. Clearly show the manner in which the systems fit into the available space and relate to each other and to the building elements. Indicate required sleeves and openings in general construction elements. Indicate required clearances for operation, maintenance and replacement of operating devices and equipment. Drawings shall be of appropriate scale to facilitate coordination and understanding, but not smaller than 1/4 inch scale for floor plans and 1/4 inch scale for equipment rooms and chases.
3. Conflicts: The engineer has endeavored to work out conflicts in areas where the design is congested, but has not tried to show all required offsets to coordinate with the building construction and building systems, particularly in less congested areas. The intent is that the Contractor coordinate the design of the piping and ductwork distribution systems with the building construction and the various building systems, particularly in less congested areas. Provide experienced designers to perform such services and prepare shop drawings. Exercise good design practice in working out conflicts without compromising system operation or maintenance. Provide fittings, offsets, etc., as required. Contractor shall include this design effort and include the labor and materials for such fittings and offsets in his base bid. Except in extremely unusual circumstances, no additional costs will be allowed related to working out conflicts. Coordinate with other disciplines as required. Identify on the shop drawings those areas where redesign was necessary to resolve design conflicts.

a. In the event that the Contractor desires direction in resolving a design conflict or desires prior approval of a recommended approach to resolving a conflict, submit an RFI which identifies the conflict and suggests a recommended solution.
b. In resolving conflicts, gravity lines and larger distribution mains will generally have priority over pressurized lines and smaller lines as follows:

Plumbing waste and vent lines
Roof drains
Steam and condensate piping
Supply, return and exhaust ductwork
Fire sprinkler mains
Heating hot water and chilled water piping
Domestic hot and cold water
Fire sprinkler branch piping and sprinkler runouts
Pneumatic control piping
Miscellaneous special piping systems

4. Use of Engineer’s CADD Database or BIM Model: The Engineer will provide the Contractor electronic files of the Engineer’s CADD Database or BIM Model of the design documents if the Contractor completes and submits the License Agreement form included at the end of this spec section. These files show the general design intent and may be used as a starting point for the Contractor to begin his shop drawings and coordination effort, but the Contractor should not use them as a basis for ordering or fabrication. The normal submittal process still applies, regardless whether the Contractor

elects to use the Engineer's CADD Database or BIM Model.

D. Submittals Required under this Specification Section:

1. Electrical Components: Motors, Motor Controllers, and Variable Speed Drives
2. Identification: Products used to identify equipment, ductwork, valves, piping, and control devices.
3. General Construction Components: Roof Curbs & Access doors.

1.9 DOCUMENTED COORDINATION EFFORT

A. After shop drawings are reviewed, incorporate any review comments and then participate in a formal and documented coordination effort with the contractors and subcontractors for other divisions of the work. Show all piping systems and equipment on the ductwork drawings, and send electronic CADD files to the General Contractor and the subcontractors for plumbing, fire protection, electrical, and other disciplines. The other subcontractors will then add their work to the CADD files.

1.10 MISCELLANEOUS PROVISIONS

A. Qualifications

1. All mechanics shall be skilled in their respective trade.
2. All welders shall be certified in accordance with the ASME Boiler Test Code, Section IX, latest issue.

B. Regulated Materials: Comply with all state, local and federal regulations regarding the storage, handling or disposal of oils, lubricants, cleaning agents, refrigerants, other liquids and gases, and hazardous materials.

C. Factory Identification: Provide all materials and equipment with labels sufficient to show compliance with these specifications and the performance requirements indicated on the drawings. All equipment shall carry a permanent label installed by the manufacturer stating that the equipment complies with ASHRAE/IESNA Std. 90.1.

D. Hazardous Conditions: Protruding metal (bolts, steel angles, etc.) potentially hazardous to maintenance and operation personnel, shall be cut back and/or protected to reduce the risk of injury.

E. Hazard Signs

1. Provide a sign reading, "Hazardous Area - Authorized Personnel Only" on the doors to all equipment rooms, fan plenums, and similar areas containing moving or rotating parts, or other potentially hazardous environments.
2. Provide a sign reading, "Confined Space - Entry by authorized personnel only by permit" for all confined spaces. Confined spaces shall be as designated by OSHA Standard 1910.146. This generally means a space that:

a. Is large enough and so configured that an employee can bodily enter and perform assigned work; and
b. Has limited or restricted means for entry or exit (for example, tanks, vessels, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry); and
c. Is not designed for continuous employee occupancy.

3. Survey the final premises to determine where any potentially hazardous areas exist. If the Contractor feels that hazards exist which cannot be suitably provided for through the above typical methods, he shall forward in writing his concerns, and request for a decision concerning the referenced hazard, prior to the final inspection of the facilities.

1.11 GUARANTEE-WARRANTY

A. See Division 1 for additional information on warranties. Warranties shall run for one year from substantial completion unless indicated otherwise.

PART 2 - PRODUCTS

2.1 PRODUCT GENERAL REQUIREMENTS

A. General: Products supplied under Division 23 shall comply with the following except as noted elsewhere.

B. Products shall be new; shall be the product of manufacturers regularly engaged in the production of plumbing, heating, ventilating, air conditioning, and control system equipment; and shall be the manufacturer's latest design. Specs and equipment schedules establish expectations regarding standard of quality and operating intent.

C. Hazardous or Environmentally Damaging Materials: Products shall not contain asbestos, mercury, PCBs, or other materials harmful to people or the environment.

D. Products shall be suitable for the conditions under which they are installed and operated. Prior to or during the submittal phase advise the Owner’s representative and the Engineer in writing regarding any concerns about the suitability of the specified products for the intended application or service. Request clarification if any question exists regarding the design intent.

E. Performance Ratings: Unless otherwise noted, all scheduled equipment performance is based on an elevation of **4000** feet above sea level. Adjust manufacturer's ratings accordingly.

F. Structural Soundness: Products shall have structural integrity appropriate to the component and its application. Bases shall be rigid and shall keep all components in proper alignment. Structural integrity shall be adequate for both rigging and final installation. Components shall not be loose, rattle, or vibrate unnecessarily in their final installed condition.

G. Corrosion Resistance: Equipment shall be of materials inherently corrosion resistant, or shall be finished with a corrosion-resistant finish suitable for the location in which the equipment is installed.

H. Touch-up: If the factory finish of any component is damaged prior to substantial completion, touch up to original condition per manufacturer's recommendations.

I. Equipment Access Doors or Panels: Provide access doors and panels within equipment to ensure good access to all components requiring inspection, service or maintenance. Provide appropriate hardware. Equipment installed outdoors shall be weather-tight.

J. Fans: Statically and dynamically balanced, shaft first critical speed shall be above operating speed at design conditions.

K. Bearings: Grease lubricated or permanently lubricated.

L. V-Belt Drives: All components sized for 150% of motor HP, multiple belts shall be matched, fixed sheaves for motors 20 Hp and larger, adjustable sheaves for lower HP motors, all safety components for OSHA compliance (e.g., belt guard or other safety provisions) motor mounted on adjustable base. Provide a replacement sheave for each fixed sheave after T&B is complete. Include belt data in O&M manual. Gates Rubber Co, OAE.

1. Belt Guards: Rigidly constructed and attached, removable, galvanized steel, expanded mesh. Design to provide ready access to bearings.

M. Couplings: Provide coupling guard.

N. Motors and VFDs: See requirements described elsewhere in this spec section.

O. Drive Lines (starter or VFD, motor, coupling and shaft or v-belt drive and pulleys, and driven equipment): Coordinate with all suppliers and ensure all components are compatible to work as a system.

P. Coils: ARI rated, copper tubes mechanically expanded into aluminum fins, galvanized steel casing, drainable, pressure tested to 150% of working pressure but not less than 300 psi.

Q. Cooling Coil Drain Pans: Provide for all cooling coils, galvanized or stainless steel, double pitched with piped outlet. For units with more than one coil stacked, provide intermediate drain pans piped to the main drain pan.

R. Gas Burners: Natural gas fired, performance based on gas at 1000 Btu/SCF HHV but suitable for use with gas at 900 – 1050 Btu/SCF and 7 – 11 inches water column, factory installed and pressure tested gas train, all necessary safety and operating controls.

S. Filter Frames: Galvanized steel, provide wherever filters are specified.

T. Roof Curbs and Support Rails for Roof-Mounted Equipment: Roof curbs should generally be supplied with the equipment which the curb supports, and shall comply with the requirements of the National Roofing Contractors' Association. Match curb to the requirements of the supported equipment. The roof pitch is indicated on the architectural drawings. If roof pitch exceeds the recommendations of the equipment manufacturer, provide a curb that will level the

equipment. Factory fabricated, minimum 12-inch, structurally adequate for the load supported, not less than welded 18-gauge (16-gauge or heavier for sizes more than 50-inches) galvanized steel with minimum 1-inch fiberglass insulation, 2 x 2 wood nailer, and with cant and step if required to match specified roof. Provide damper tray for un-ducted fan applications. Ship small curbs fully assembled; large curbs may be knocked down for shipment.

U. Electrical & Controls: Except where specifically noted, electric service to each component listed on the equipment schedules will be through a single electrical feed at the voltage indicated on the equipment schedules. Include all components, cabling and conduits to distribute power to all components which are factory supplied and mounted. Provide transformer(s) if required to serve unit-mounted components requiring electric service at voltages different from the main electric service, including controls components. Provide secondary overcurrent protection. Provide terminal strips for field-installed control wiring. Provide unit-mounted, unit-specific wiring diagrams on durable paper, attached to inside of control panel door or otherwise affixed to the unit. All electrical components shall be UL Listed or Recognized. All factory-installed electrical work shall comply with the NEC unless the overall unit is listed by an organization acceptable to the AHJ, and listed to a standard acceptable to the AHJ.

1. Where equipment includes an LCD or other, similar display for operator interface, display all information in English. Displays should be readily understandable and should not require the user to look up display codes in a reference manual.
2. Provide battery backup to retain all memory and programming, and to keep all clock-related functions powered through a 1-week power outage.
3. Controls interface with the FMS:

    a. Digital Inputs to FMS: 24V DC sourced from equipment.
    b. Digital Outputs from FMS: Equipment to have form C relays, max 250V DC, 2 A.
    c. Analog Inputs to FMS: 4-20 mA, 0-5V DC, or 0-10V DC sourced from equipment.
    d. Analog Outputs from FMS: 4-20 mA sourced from FMS.

2.2 ELECTRICAL COMPONENTS

A. General: Except as noted, all electrical products and equipment shall comply with the requirements of this section, whether field installed or factory installed. See “Product General Requirements” and “Installation General Requirements” in Parts 2 & 3 of this spec section for additional requirements.

B. Motors

1. General: Except as noted motors shall be horizontal, open drip-proof, 4-pole, 1750 RPM, rated per NEMA MG-1, with fabricated steel or cast iron casing, motor terminal box adequately sized for conductors one-size larger than specified, SS nameplate per NEMA MG-1-20.60, connection diagram attached to motor, compression lugs for power feeds and ground conductor, grease lubricated sealed ball bearings or roller bearings with standard grease fitting zerk and relief tapping, factory lubricated, dynamically balanced to no more than 50% of the NEMA allowable vibration limits. For motors powering V-belt drives, provide a cast iron or steel base with slide rail and adjustable belt tension device. Install motors and equipment on foundations and align as required. 40 deg C rise

and total temperature rise of 65 deg C ambient.

a. 3/4 hp and smaller: 115V, single phase, 60 Hz, split phase or permanent split capacitor (PSC), NEMA Type N or O, with built-in thermal overload protection.
   1) Multi-speed motors.

b. 1 hp and greater: 208 V, 3 phase, 60 Hz, squirrel cage induction type, NEMA design B, T-frame, with Class B or F insulation, lifting lugs, 150,000 hr L-10 bearings for direct-coupled applications, 50,000 hr L-10 bearings for belt-driven application with radial loads and pulley sizes per NEMA MG1-14.43. Service Factor: ODP motors shall be rated for 1.15 SF at 40°C or 1.0 SF at 65°C; TEFC motors shall be 1.0 SF.
   1) Two speed motors: Provide with two separate windings.
   2) Variable speed motors: Drive compatible per NEMA MG1-31, premium efficiency as specified below regardless of Hp, Class F insulation, minimum 5-year warranty.

2. Efficiency: Except as noted, motors shall be premium efficiency type, with nominal efficiencies not less than the following as per the Consortium on Energy Efficiency (CEE), and minimum power factor of 0.85:

	Open Drip-Proof (ODP)			Totally Enclosed Fan-Cooled (TEFC)		
HP	1200 RPM	1800 RPM	3600 RPM	1200 RPM	1800 RPM	3600 RPM
1	82.5	85.5	80.0	82.5	85.5	78.5
1.5	86.5	86.5	85.5	87.5	86.5	85.5
2	87.5	86.5	86.5	88.5	86.5	86.5
3	89.5	89.5	86.5	89.5	89.5	88.5
5	89.5	89.5	89.5	89.5	89.5	89.5
7.5	91.7	91.0	89.5	91.7	91.7	91.0
10	91.7	91.7	90.2	91.7	91.7	91.7
15	92.4	93.0	91.0	92.4	92.4	91.7

3. Approved Manufacturers: General Electric Energy Saver, Baldor Super-E, Marathon Series E, Reliance Electric XE, Westinghouse TEE II, Eaton/Cutler Hammer, Toshiba, Louis Allis, or approved equal.
4. If the Contractor proposes to furnish motors varying in horsepower and/or characteristics from those specified, he shall first submit his request for the change and shall then coordinate the change with all other parties (e.g. electrical contractor) and pay any costs associated with the change.

C. Motor Controllers

1. Single Phase Manual Starters to 1 Hp and 120-277 V: Cutler Hammer MS with indicating light.
2. 3-Phase: Full voltage, non-reversing, electro-mechanical, combination circuit breaker and motor controller, UL Listed, NEMA rated, 460V, 65,000 AIC, minimum 50 VA 24V controls transformer with secondary overcurrent protection, suitable for operation at -4°F to +149°F and specified voltage -15% to + 10%, adjustable solid state overloads initially set at Class 10, HOA switch, run indicator, two auxiliary contacts for remote monitoring of status, and enclosure for surface mounting. Cutler Hammer OAE.

a. Provide enclosure appropriate to the location:
   1) NEMA-1 for indoor dry locations.
   2) NEMA-3R for outdoors.
   3) NEMA-4 for wet applications.
   4) NEMA-12 for dusty locations.
   5) Explosion-proof – where required.
b. Motor controllers factory mounted and wired on AC units, boilers, etc, may be definite purpose, and need not have all the features specified here.

2.3 ELECTRICAL WIRING AND CONTROL EQUIPMENT

A. Provide wiring and conduit as scheduled in Section 23 0549.

B. Coordinate with all disciplines to ensure that all necessary components of control work are included and fully understood.

2.4 IDENTIFICATION

A. Scope: Identify all equipment, ductwork, valves, piping, and control devices shown on the Drawings, identified in the equipment schedules, and indicated in these Specifications. Provide submittals for products and procedures used for identification.

B. Equipment: For all mechanical equipment supplied or installed under Division 23, provide an equipment identification tag or stencil unit number onto the equipment. Stencils shall be minimum 3-inch height, dark contrasting color, of a material suitable for the application.

1. For rooftop HVAC equipment, provide a permanently affixed, weather-resistant label to identify the areas served.

C. Valves: Provide each valve with a stamped metal tag secured to the valve. Tag shall indicate the valve number, service and function. Provide two sets of prints of drawings showing floor plan for each floor with all valves accurately located and labeled. Drawings shall be neat and easily readable. Provide a typed valve chart, listing the valve number, size, location, function, normal operating position, for each valve. List valves by system, i.e., domestic cold water, hot water, chilled water, etc. Tags shall be stamped brass 1-1/2" diameter, and secured to valves by heavy copper figure eight hooks, braided stainless steel wire anchor, or other approved means.

D. Ductwork: Identify ductwork at or near the fan with stenciled signs on insulated ductwork or engraved laminated plastic signs secured by rustproof screws on un-insulated ductwork. Sign shall identify air conditioning system or fan unit and area served.

E. Piping

1. Provide color-coded pipe labels indicating the service of the pipe and the direction of flow. Piping labels shall comply with ANSI Standard A13.1 regarding color coding and size of lettering. The following standardized color code scheme shall be used:

   a. Yellow - Hazardous Materials.
   b. Green - Liquid Materials of Inherently Low Hazard.

c. Blue - Gaseous Materials of Inherently Low Hazard.
d. Red - Fire Protection Materials.

2. Labels shall be vinyl material with permanent adhesive for application to clear dry pipe and/or insulation jacketing. Pressure sensitive pipe tape matching the background color of the label shall be placed over each end of the label and completely around the pipe.
3. For retrofit projects the system names shall match existing.
4. Attach pipe markers to lower quarter of the pipe on overhead horizontal runs and on the centerline of vertical piping where view is not obstructed.
5. Provide the following labels, with ANSI/OSHA color and banding for all piping systems as shown on the Drawings and as listed below:

Service/Legend	Letter Color	Background Color	Tape Banding Color
Domestic Cold Water	White	Green	2" Green
Domestic Hot Water	Black	Yellow	2" Yellow
Domestic Hot Water Return	Black	Yellow	2" Yellow
Soft Cold Water	White	Green	2" Green
Soft Hot Water	Black	Yellow	2" Yellow
Industrial Cold Water	White	Green	2" Green
Fire Protection Water	White	Red	2" Red
Fire Auto Sprinkler	White	Red	2" Red
Fire Dry Standpipe	White	Red	2" Red
Fire Wet Standpipe	White	Red	2" Red
Fire Comb. Standpipe	White	Red	2" Red
Compressed Air	White	Blue	2" Blue
Roof Drain	White	Green	2" Green
Sanitary Sewer	White	Green	2" Green
Storm Sewer	White	Green	2" Green
Natural Gas	Black	Yellow	2" Black

6. Medical gases: See Section 22 6000, Medical Gas and Vacuum Systems

7. Locations: Label pipes at the following points on each piping system:

a. Adjacent to each valve in piping system.
b. At every point of entry and exit where piping passes through a wall.
c. On each pipe riser and junction.
d. At a maximum interval of 20 feet on pipe lines exposed and concealed above accessible ceilings.
e. Adjacent to all special fittings (regulating valves, etc.) in piping systems.
f. At every access door.

8. Underground Piping: Provide a continuous, preprinted, bright colored, plastic ribbon cable marker with each underground pipe regardless of whether encased. Locate directly over buried pipe, 6 inches to 8 inches below finished grade. Marker tape used in conjunction with buried plastic piping systems shall be special detector type.

F. Control System Devices: All automatic controls, control panels, zone valves, pressure electric, electric pressure switches, relays and starters shall be clearly tagged and identified. Wording shall be identical to that on the control diagram in the Contract Drawings.

2.5 GENERAL CONSTRUCTION COMPONENTS

A. Roof Curbs and Equipment Support Rails

1. General: Factory fabricated, minimum 12-inch high, galvanized steel, configured to account for roof pitch where pitch exceeds 1/4-inch/ft or where required by manufacturer of supported equipment. Coordinate with roofer and provide cant and step if needed to match roof construction. Actual curb heights to be coordinated by contractor with roofing insulation height to maintain code-required height above final roofing elevation.
2. Roof Curbs: 1.5-inch fiberglass insulation with nominal 2" x 2" wood nailer. Provide damper tray where a damper is indicated. Thycurb TC, Greenheck, RPS, OAE.
3. Equipment Support Rails: Nominal 2" x 4" wood nailer. Thycurb TEMS, Greenheck, RPS, OAE.

B. Access Doors (ADs)

1. Steel frame and door, surface mounted, factory primed, 150^{o} opening, flush, screw-driver operated cam lock, minimum 24” x 24” except as approved, but larger where required for proper access. Where ADs are installed in general construction with a pattern, match AD dimensions to this pattern. Milcor, Krueger, OAE.

    a. Sheet Rock Wall or Ceiling: With drywall bead on frame, Milcor Style DW.
    b. Plaster Wall or Ceiling: Milcor Style K.
    c. Masonry Walls: Milcor Style M.
    d. 1-hr and 2-hr rated walls: UL Listed for 1.5-hr Class B Fire Rating, self-closing and self-latching. Milcor Style UFR.
    e. Suspended Ceilings: Milcor Style AT.
    f. Fire Rated Suspended Ceilings: Milcor Style ATR.

C. Painting: Finish painting of mechanical systems and equipment will be under Spec Section 09 9100, “Painting," unless equipment is specified to be provided with factory-applied finish coats.

2.6 MISCELLANEOUS PROVISIONS

A. Flow Diagrams: Provide half-size prints of each system flow diagram, including air handling, steam, chilled water, heating water, domestic water, domestic HW, etc. Mount framed under plexiglass, and locate either on the associated AHU or on a nearby wall. Incorporate any as-built revisions.

PART 3 - EXECUTION

3.1 INSTALLATION GENERAL REQUIRMENTS

A. Cooperation with Other Trades: Refer to other parts of these Specifications covering the work of other trades which must be carried on in conjunction with the mechanical work so that the construction operations can proceed without harm to the Owner from interference, delay, or absence of coordination. Be responsible for the size and location of all openings, foundations, etc.

B. Trenching and Backfilling: Provide all excavation, trenching and backfilling required for the installation of the work of this division.

C. Manufacturer's Instructions: Install all products in accordance with manufacturers' recommendations and the requirements of any applicable listings. If manufacturers' recommendations and/or requirements of applicable listings conflict with plans and specifications, report such conflicts to the Owner's Representative.

D. Field Measurements: Verify all dimensions and conditions governing the work. Examine adjoining work on which the work of this Division is dependent, and report any deficiencies.

E. Do not compromise the building structural, fire resistant construction or vapor barrier system.

F. Supports for Equipment and Systems: Foundations and structural supports for equipment will generally be provided by others. The contractor for this division shall provide supplementary supports as required to support equipment, distribution systems, and other components installed under this division. Prior to installing mechanical work, examine foundations and supports to ensure they are adequate to properly support the equipment. Provide all necessary foundations, structures, supports, inserts, sleeves, etc, for installation of mechanical and plumbing equipment, ductwork and piping, etc. Coordinate installation of such devices with all disciplines. Verify that the devices and supports are adequate as intended and do not overload the building structure.

G. Concealed or Buried Work: For work which is underground or which will be concealed by building construction, provide digital photographs to document the installation throughout the construction project, but not less than weekly. Include plans indicating where the photographs were taken. Notify the OR of when the work will be complete and provide OR a minimum five-day period to inspect the work after completion but prior to when it is backfilled or concealed by building construction.

H. Access Doors: Provide as required for access to valves, dampers, controls, or other items for which access is required for either operation or servicing. The type of access door shall be as required by the room finish schedule.

I. Alignment of Flexible Couplings: Flexible couplings between motors and driven equipment shall be aligned by a qualified service technician after the equipment is installed and ready for operation. Align equipment per manufacturer's recommendations under operating conditions and temperature. Provide written certification that each device has been so aligned.

J. Lubrication: Provide all oil for the operation of all equipment until acceptance. Be responsible for all damage to bearings while the equipment is being operated by Contractor up to the date of acceptance of the equipment. Protect all bearings and shafts during installation and thoroughly grease shafts to prevent corrosion. Bearings for items of mechanical equipment shall be marked at each bearing location as to whether the bearing is a sealed type or relubricable type unit.

K. Tests: All tests shall be conducted in the presence of the designated and authorized Owner's Representative. Notify the Owner's one week in advance of all tests. Requirements for testing are specified under the sections covering the various systems. Provide all necessary equipment, materials, and labor to perform the required tests.

L. Protection of Material and Equipment:

1. Protect all work, materials and equipment furnished and installed under Division 23, whether incorporated in the building or not.
2. All items of mechanical equipment shall be stored in a protected weatherproof enclosure prior to installation within the building, or shall be otherwise protected from the weather in a suitable manner as approved.
3. Protect all work and be responsible for all damage done to property, equipment and materials. Coordinate material storage with the Owner's Representative.
4. Pipe and duct openings shall be closed with caps or plugs, or covered to prevent lodgment of dirt or trash during the course of installation. Plumbing fixtures shall not be used by the construction forces. At the completion of the work clean and polish fixtures, equipment and materials prior to turning them over to the Owner.

3.2 DRAWINGS

A. The drawings show the general arrangement of the piping, ductwork, equipment, etc. Follow them as closely as actual building construction and work of other trades will permit. Where discrepancies occur between Plans and Specifications, the more stringent shall govern. All Contract Documents shall be considered as part of the work. Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings and accessories, which may be required, and no attempt has been made to do so. Rather, the drawings convey the general design intent. Investigate the structural and finish conditions affecting the work and arrange the work accordingly, providing fittings, valves, and accessories as required to meet such conditions. Show any such changes on the Record Drawings.

B. Should any doubt or question arise in respect to the true meaning of the drawings or specifications, submit an RFI.

C. Install equipment, piping, ductwork, and electrical systems with proper clearance for operation, service, and maintenance, including minimum clearances required by applicable codes, manufacturer's installation instructions, etc. Include proper clearance in front of and above electrical equipment as defined by the National Electric Code (NEC). Piping and ductwork systems shall not be routed through or above electrical equipment rooms, telecommunications rooms, elevator machine rooms, or electrical equipment spaces within mechanical equipment rooms.

D. Arrange all concealed mechanical systems carefully to fit within the available space without interference with adjacent structural and electrical systems. Make all necessary provisions for

penetrations of piping and ductwork, including sleeves and blockouts in structural systems. The exact location of all exposed mechanical systems, including grilles, registers, and diffusers; access doors; sprinkler heads; piping and ductwork exposed within finished areas; and other equipment and devices as applicable, shall be coordinated with the Architect, who shall have final authority for the acceptance of the work as it relates to the aesthetic design for the facility.

3.3 EQUIPMENT SUPPLIED BY OTHERS

A. Certain items of mechanical equipment as listed on the Drawings and/or Specifications will be furnished under other sections of this Specification for mechanical rough-in and connection under Division 23, including plumbing, domestic water and waste, compressed air, exhaust, etc. All required mechanical services, including connection of such services to equipment shall be provided under Division 23.

3.4 CONCRETE BASES AND HOUSEKEEPING PADS

A. Concrete bases and housekeeping pads shall be installed under all pieces of mechanical equipment unless specifically deleted by the Specifications or Drawings.

B. Be responsible for the accurate dimensions of all pads and bases and furnish and install all vibration isolators, anchor bolts, etc.

C. Provide concrete housekeeping pad foundations for all floor mounted equipment installed under this section unless otherwise shown on the Drawings. All concrete bases and housekeeping pads shall conform to the requirements specified under Division 3, Concrete, portions of these Specifications. Pad foundations shall be 4 inches high minimum, unless otherwise indicated on the Drawings. Chamfer edges shall be 1 inch. Faces shall be free of voids and rubbed smooth with carborundum block after stripping forms. Tops shall be level. Provide dowel rods in floor for lateral stability and anchorage.

D. Equipment anchor bolts shall be set in a galvanized pipe or sheet metal sleeves 1 inch larger than bolt diameter. Anchor bolts shall be high strength steel J-shape. Anchor bolt design shall be arranged and paid for by the Contractor.

E. Machinery bases, bed plates, sole plates, or vibration isolation units shall be carefully aligned, shimmed, leveled, and then grouted in place with commercial non-shrink grout. When a flexible coupling is employed as a part of the drive train, the coupling shall be aligned before the machinery base is grouted.

3.5 SEISMIC RESTRAINTS

A. The Contractor shall be responsible for all anchors and connections for the mechanical work to the building structure to prevent damage of equipment and systems due to earthquakes. The complete fire protection systems shall be supported as required to resist stresses produced by lateral forces as required by NFPA No. 13. Where mechanical equipment, piping, and ductwork are connected to the building structure, exact method and means of attachment to the structural system shall be approved.

B. See Section 230 548 for requirements for seismic supporting of mechanical equipment and systems.

3.6 PRESSURE RELIEF DEVICES

A. Refrigerant pressure relief devices and fusible plugs shall be installed with piping to a safe location in accordance with ANSI/ASHRAE Standard 15. Discharge shall be to atmosphere at a location not less than 15 feet above the adjoining ground level and not less than 20 feet from any window, ventilation opening, or exit from any building. Discharge line sizing shall conform to ANSI/ASHRAE Standard 15-1994.

B. Each discharge pipe shall be equipped with a drip leg capable of holding 1 gallon of liquid. The drip leg shall include a manual drain valve.

3.7 INSTALLATION CHECK

A. An experienced, competent, and authorized representative of the equipment listed below shall visit the site of the work and inspect, check, adjust if necessary, and approve the installation for the equipment listed below. The equipment supplier's representative shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation is approved and accepted.

B. Each equipment supplier's representative shall furnish a written report certifying that the equipment (1) has been properly installed and lubricated; (2) is in accurate alignment; (3) is free from any undue stress imposed by connecting piping or anchor bolts; and, (4) has been operated under full load conditions and that it has operated satisfactorily.

C. Equipment requiring installation check includes the following:

VRF Condensing Unit and Fan Coil Units
Facility Management System (See Specification Section 23 0900)

3.8 OPERATION PRIOR TO ACCEPTANCE

A. Operation of equipment and systems for the benefit of the Owner prior to substantial completion will be allowed provided that a written agreement between the Owner and the Contractor has established warranty and other responsibilities to the satisfaction of both parties.

B. Operation of equipment and systems for the benefit of the Contractor, except for the purposes of testing and balancing, will not be permitted without a written agreement between the Owner and the Contractor establishing warranty and other responsibilities.

3.9 OPERATION AND MAINTENANCE (O&M) INSTRUCTIONS

A. At completion of the project provide two complete bound sets of the following documents, along with two CDs containing searchable PDFs of these documents. Organize bound information in a logical fashion with a table of contents and tabs for the different sections.

Organize PDFs in a logical fashion with bookmarks to assist the operating personnel in retrieving desired data. Provide minimum two 1-hour sessions to instruct Owner's facility personnel in how to find information in the bound O&Ms and the PDFs. Take attendance and submit the attendance list to the Owner's Representative. Include the following:

1. Approved Submittals.
2. Test reports.
3. O&M manuals and instructions covering all equipment supplied under this Division, with all non-applicable information crossed out. Clearly identify all required routine maintenance. Include parts lists.
4. A master Lubrication Chart listing each piece of equipment, the recommended oil or grease, and the recommended frequency of lubrication.
5. The names and addresses of at least one service agency capable of providing required maintenance for each item of equipment supplied.
6. Complete temperature control diagrams including control descriptions, system sequence of operation, operating instructions, control system maintenance and calibration information, wiring diagrams, and all control setpoints. See Section 23 0900 for additional requirements.

B. See Division 1 for additional requirements concerning manuals, manual distribution, and maintenance materials.

C. Submit O&M manuals for review and distribution to the Owner not less than two weeks prior to the date scheduled for O&M instructions as specified.

D. Demonstrate proper system operation to the owner's operating staff. Provide the services of the contractor and subcontractors (e.g., mechanical, T&B, temperature control, etc), as required to properly demonstrate system operation.

E. Provide the necessary skilled labor and helpers to operate the mechanical systems and equipment for a period of 3 days of eight hours each. During this period, instruct the owner’s facility staff fully in the operations, adjustment and maintenance of all equipment provided. Provide at least two weeks advanced notice, with a written schedule of each training session, the subject of the session, the Contractors' Representatives who plan to attend the session, and the time for each session. Take attendance and submit attendance sheets to the Owner's Representative.

3.10 RECORD DRAWINGS

A. See Division 1, for additional requirements associated with Project Record Drawings.

3.11 SITE VISITS AND OBSERVATION OF CONSTRUCTION

A. The Engineer may make periodic visits to the project site at various stages of construction in order to observe the progress and quality of various aspects of the work so as to determine if such work is proceeding in general accordance with the Contract Documents. This observation will not release the Contractor from his responsibility to supervise, direct, and control all construction work and activities. The Engineer has no authority over, or responsibility for

means, methods, techniques, sequences, or procedures of construction or for safety precautions and programs, or for failure of the Contractor to comply with applicable laws, regulations, or codes.

B. Prior to substantial completion, request that the Engineer provide a final observation visit. Complete the attached "Final Observation Checklist," and include it with this request. For any items that are not applicable, mark them "N/A."

3.12 PROJECT CLOSEOUT

A. Submit written certification that all work complies with the specifications and applicable codes. Submit certifications and acceptance certificates including proof of delivery of record drawings, O&M manuals, spare parts required, and equipment warranties.

END OF SECTION 230500

Project:_____ Date Submitted:_____

General Contractor:_____ Date of Final Mechanical System:_____

Mechanical Contractor:_____ Observation Requested:_____

CONTRACTOR'S MECHANICAL & PLUMBING CHECK LIST
(ALL APPLICABLE ITEMS MUST BE COMPLETED PRIOR TO FINAL OBSERVATION)

In advance of requesting a final mechanical observation for installed mechanical systems, please check all items that have been completed. For all items not applicable to this project mark N/A.

PLUMBING/PIPING

_____1. All plumbing fixtures are set, sealed and cleaned.

_____2. All domestic and HVAC pipe systems are insulated.

_____3. All pipe systems are identified with specified labels and directional arrows.

_____4. Floor sinks and drain grates are cleaned and debris removed.

_____5. Valve tags are installed.

_____6. Special equipment (water softeners, water heaters, piping systems, etc.,) have been checked and put into service.

_____7. Medical gas systems have been checked and certified.

_____8. Special piping systems have been cleaned and pressure tested.

_____ Fuel Handling
_____ Compressed Air
_____ Natural Gas
_____ Other

_____ Process Piping
_____ Nitrogen
_____ Vacuum
_____ Argon
_____ Medical Gas
_____ Other

_____9. Limestone chips have been installed in acid dilution sumps.

_____10. Plumbing/piping connections have been completed to Owner-furnished equipment and equipment furnished by other Contractors/Subcontractors.

_____11. Exterior wall hydrants have been cleaned.

_____12. Concrete collars have been installed at clean-out to grade, valve box, or other specified plumbing items.

_____13. Drains and relief lines from plumbing and HVAC equipment have been installed and secured in a proper manner.

_____14. All plumbing equipment and areas of equipment have been cleaned and debris removed.

_____15. All plumbing equipment required by the Specifications has been identified and/or numbered.

_____16. Domestic water systems sterilization has been completed.

_____17. Refrigerant piping/system has been charged and tested.

_____18. Strainers/suction diffusers have been cleaned.

_____19. Backflow preventers have been tested.

_____20. Air has been vented from all coils and systems.

_____21. Water treatment systems have been charged and tested.

_____ Chilled Water
_____ Hot Water
_____ Condenser Water
_____ Steam/Condensate

_____22. Ethylene glycol system has been charged with correct mixture and tested.

_____23. Water systems have been cleaned (X) and pressure tested (P)

_____ Chilled Water
_____ Hot Water
_____ Steam
_____ Condensate
_____ Fire Protection
_____ Sanitary Sewer and Vent
_____ Roof and Overflow Drains
_____ Condenser Water
_____ Non-potable Water
_____ Domestic Hot Water
_____ Domestic Cold Water
_____ Acid Waste and Vent
_____ Heat Recovery Piping
_____ Other (list)

_____24. PRVs have been adjusted (water, steam, gases).

FIRE PROTECTION

_____1. Fire protection piping is completed.

_____2. Fire protection system has been certified by the Fire Marshal's office.

_____3. All electrical interlocks between the fire sprinkler components and the fire panel have been checked for operation.

_____4. Spare sprinkler head, wrench and cabinet are installed.

HVAC - EQUIPMENT AND DUCTWORK

_____1. All ductwork has been sealed and insulated.

_____2. Return air paths and transfer openings have been verified.

_____3. Air handlers have been cleaned inside and out and construction filters removed and replaced with final filters.

_____4. All air handling equipment has been started and operated for the specified time.

_____5. All equipment isolators have been adjusted for specified deflection.

_____6. All VAV boxes, fan coils, or fan powered boxes are completed and operational.

_____7. All pump shafts and couplings have been aligned.

_____8. Ductwork, coils, housing, diffusers, registers and grilles have been cleaned.

_____9. Boilers have been fired and certified by the supplier.

_____10. Cooling towers have been started and inspected by the supplier.

_____11. Chillers have been charged, started and certified for operation by the supplier.

_____12. Fire dampers are accessible and fully operational.

_____13. All HVAC equipment has been lubricated.

_____14. HVAC equipment has been labeled in accordance with the Specifications.

_____15. Duct pressure testing is complete and accepted.

_____16. "HAZARDOUS AREA" signs installed where applicable.

_____17. Belt guards installed where applicable.

_____18. Variable frequency drives have been tested by the manufacturer's representative and certified to be in compliance with all of the specified requirements.

_____19. Testing and balancing has been completed, and deficiencies noted have been corrected.

_____20. Special systems have been started and tested, such as: Humidification, laboratory hoods, kitchen hoods, and Owner-furnished items.

TEMPERATURE CONTROLS

_____1. Temperature control panels and devices have been labeled in accordance with the Specifications.

_____2. All control dampers close completely and edge and blade seals form tight seal.

_____3. All control valves have been piped as required by the Drawings.

_____4. Controls systems are completed and all control points are operating and recording properly.

_____5. All temperature control tubing and wiring is installed and secured in accordance with the Specifications and the electrical code.

_____6. Smoke removal fans and/or smoke detectors have been tested for operation and shutdown.

_____7. Freezestats have been tested ensuring fan shutdown and full damper closure.

_____8. Operator training for temperature controls has taken place.

_____9. Refrigerant sensors and equipment room shutdown have been tested.

GENERAL ITEMS

The following specified items have been submitted:

_____1. Record Drawings (to be submitted prior to final payment to the Contractor).

_____2. Operation and maintenance manuals.

_____3. Manufacturer's representative installation check and certification submitted (see list of equipment, Section 23 0500).

_____4. Testing and balancing reports.

_____5. Test kits furnished to Owner.

_____ Flow Measuring Devices
_____ Flow Balance Valves
_____ Flow Control Devices

_____6. Temperature control schematics and sequence of operation.

_____7. Wall-mounted lubrication, valve, and temperature control charts have been installed.

Note to Spec Editor: Coordinate substitution procedures with Architect. If a

DIVISION 23
SUBSTITUTION

REQUEST FORM (SRF)

TO: **BRIDGERS & PAXTON CONSULTING ENGINEERS**
PROJECT: _____

We hereby submit for your consideration the following product instead of the specified item for the above project:

Section: _____ Page: _____ Paragraph/Line: _____ Specified Item: _____

Proposed Substitution: _____

Attach complete product description, drawings, photographs, performance and test data, and other information necessary for evaluation. Identify specific Model Numbers, finishes, options, etc.

1. Will changes be required to building design in order to properly install proposed substitutions? YES ☐ NO ☐
   If YES, explain: _____
2. Will the undersigned pay for changes to the building design, including engineering and drawing costs, caused by requested substitutions? YES ☐ NO ☐
3. List differences between proposed substitutions and specified item.

Specified Item	Proposed Substitution
_____	_____
_____	_____

4. Does substitution affect Drawing dimensions? YES ☐ NO ☐
5. What affect does substitution have on other trades? _____
6. Does the manufacturer's warranty for proposed substitution differ from that specified? YES ☐ NO ☐
   If YES, explain: _____
7. Will substitution affect progress schedule? YES ☐ NO ☐
   If YES, explain: _____
8. Will maintenance and service parts be locally available for substitution? YES ☐ NO ☐
   If YES, explain: _____
9. Does proposed product contain asbestos in any form? YES ☐ NO ☐

SUBMITTED BY: Firm: _____ Date: _____
Address: _____
Signature: _____ Telephone: _____

For Engineer's Use Only

Accepted _____ Not Accepted _____ Received Too Late _____
By: _____ Date: _____
Remarks: _____

LICENSE AGREEMENT FOR CADD DATABASE OR BIM MODEL

PROJECT: _____

LICENSE GRANT: Contractor is granted use of the CADD Database or BIM Model (Database/Model) for the indicated project for the specific purpose of preparing submittal documents for this Project. No other use of the Database/Model is granted. Title to the Database/Model is not transferred to the Contractor. The Database/Model may be of value to the Contractor in preparing submittals, but use of the model does not relieve the contractor of the requirement to verify measurements in the field.

COPYING RESTRICTIONS: Contractor may copy the Database/Model in whole or in part, but only for backup and archival purposes or for use by the Contractor's Subcontractors. Contractor agrees to ensure that any entities that receive the Database/Model from Contractor, either in whole or in part, comply with the terms and conditions of this agreement. Contractor shall safeguard the Database/Model from falling into the hands of parties other than Subcontractors with a legitimate need for it.

WARRANTY: Bridgers & Paxton (B&P) offers this Database/Model without warranty and specifically without express or implied warranty of fitness. If Contractor chooses to use the Database/Model, then he does so at his own risk and without any liability or risk to B&P.

INDEMNITY: Contractor shall to the fullest extent permitted by law, defend, indemnify and hold harmless the Owner, Architect, B&P, their employees and agents from all claims, damages, losses, and attorney fees arising out of or resulting from the use of the Database/Model.

ACKNOWLEDGMENT: Contractor acknowledges that (s)he has read this Agreement, understands it, and agrees to be bound by its terms and conditions.

CONTRACTOR'S REPRESENTATIVE

Signature: _____ Company Name: _____

Name: _____ Address 1: _____

Title: _____ Address 2: _____

Date: _____

SECTION 230504 - PIPE AND PIPE FITTINGS

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

B. Lead Ban: All systems and system components, pipe, fittings, and fixtures furnished under Division 23 shall be lead free.

1. Any product designed for dispensing potable water shall meet both the NSF 61 and NSF 372 test standards via third-party testing and certification.
2. Lead free refers to <0.25% weighted average lead content in relation to wetted surface of pipe, fittings, and fixtures in systems delivering water for human consumption, and solder and flux which does not contain more than 0.2% lead.

1.2 RELATED SECTIONS

A. Section 23 0500, Common Work Requirements for HVAC.

1.3 SUBMITTAL DATA

A. Contractor shall furnish complete submittal data for all piping materials, including manufacturer's specifications, certifications, class, type and schedule. Submittal data shall additionally be furnished for pipe hangers and supports, seismic restraints, pipe sleeves including sealing and fire safing materials and installation.

PART 2 - PRODUCTS

2.1 PIPE AND PIPE FITTINGS

A. Piping system materials shall be furnished as specified under the Sections describing the various piping systems. Pipe fittings shall be compatible with the piping systems in which they are installed.

B. Pipe fittings for steel piping systems shall be weld, screwed or mechanical couplings. Butt weld fittings shall be manufactured by Weld-Bend, Laddish, or equivalent, standard or extra strong as specified in the applicable Sections of this Specification, conforming to ANSI Standard B16.9. All 90^0 weld elbows shall be long radius unless otherwise specified. Wherever tee connections are required in the piping system, manufacturer's straight or reducing tees shall be utilized. The use of fittings formed from welded pipe or pipe sections will not be permitted. Forged steel "Weld-O-Lets", "Branch-O-Lets", and "Thred-O-Lets", as manufactured by Bonney Forge or

equivalent, may be utilized for welded branch and tap connections up to one-half the size of the main. Forged steel half-couplings conforming to ANSI B16.11 may be used for drain, vent and gauge connections. Flanges shall be forged steel weld neck or slip-on, raised face, Class 150 or 300 as specified in the applicable Sections of this Specification with full face or ring type non-asbestos gasket material suitable for the application.

C. Socket weld fittings shall be Schedule 40, 2000 pound or Schedule 80, 3000 pound construction, as specified in the applicable Sections of this Specification, conforming to ANSI B16.11, as manufactured by Grinnell or equivalent.

D. Screwed fittings shall be Class 150 standard or Class 300 extra heavy, black or galvanized, malleable iron or cast iron, as specified in the applicable Sections of this Specification, as manufactured by Grinnell or equivalent. Screwed malleable iron fittings shall conform to ANSI B16.3 and cast iron screwed fittings shall conform to ANSI B16.4. Bushing reduction of a single pipe size or use of close nipples will be permitted.

E. Pipe couplings and fittings as manufactured by Victaulic, Tyco-Grinnell, or equivalent may be utilized for steel piping systems in lieu of butt weld fittings, as specified in the applicable Sections of this Specification. Couplings shall consist of ductile or malleable iron housing, with gasket, and nuts and bolts required to secure the unit. Gaskets shall be molded of synthetic rubber or other compound as recommended by the manufacturer for the fluid application including required pressure and temperature operating ranges. Fittings utilized in conjunction with Victaulic type piping system shall be manufacturer's full flow cast iron, malleable iron, or steel fittings with grooves designed to accept mechanical couplings. All piping shall be prepared in accordance with manufacturer's specifications, furnished for factory or field installed roll grooves without metal removal. Square cut grooves will not be permitted. Assembly of couplings, fittings and piping shall be in accordance with manufacturer's published instructions. Gaskets, pipe ends, fittings and coupling housings shall be properly lubricated with water-based type lubricant furnished by the coupling manufacturer. Couplings shall be Victaulic Style 07 "Zero-Flex" or equivalent, rigid coupling through 24" size. For applications in conjunction with connections to items of equipment such as boilers, water chillers, cooling towers, etc., Victaulic Style 75 or equivalent couplings shall be utilized. Adapter connections between Class 125 and 150 flanged components and grooved piping system shall be made utilizing Victaulic Style 741 and 742 or equivalent flange adapter. Branch and tap connections up to one-half the size of the main may be made utilizing Victaulic Style 72 or equivalent outlet couplings and Style 920 or 921 or equivalent branch outlet connections.

F. Pipe fittings for copper piping system shall be wrought copper conforming to ANSI B16.22. Cast brass fittings conforming to ANSI B16.23, may be utilized for sanitary drainage, waste and vent systems, HVAC gravity condensate drainage system, and other non-pressure applications.

G. Bronze flanges, Class 125 and Class 150, shall conform to ANSI B16.24.

H. Cast iron fittings for cast iron sanitary soil, waste, and venting piping systems shall be as specified in Division 22.

I. Ductile iron fittings for ductile iron water service piping systems shall be as specified in Division 22.

J. Fittings for special piping systems including, Medical Compressed Air, PVC piping systems, shall be compatible with the piping system requirements and shall be as specified in Division 22.

2.2 FLOOR, WALL AND CEILING PLATES

A. Where uncovered, exposed pipes pass through finished floors, finished walls, or finished ceilings, they shall be fitted with chromium plated spun brass escutcheon plates. Plates shall be large enough to completely close the hole around the pipe, and shall be not less than 1-1/2" or more than 2-1/2" larger than the diameter of the pipes. All plates shall be securely held in place.

2.3 UNIONS

A. Piping 2-1/2" and larger shall be provided with bolted flange union connections. Weld flanges and bolting shall conform to ANSI B16.5. Bronze flanges shall conform to ANSI B16.24. Flange class shall be as specified in the applicable Sections of the Specifications.

B. Malleable iron grooved joint unions with brass to iron seats, Class 125, 250, or 300, as required by the application and compatibility requirements with the piping system fitting classification, conforming to MSS SP-77 and ANSI B16.39, shall be provided in piping systems 2" and smaller. Copper unions conforming to ANSI B16.22 shall be provided in copper piping systems. Union connections shall be installed at all coils, control valves, equipment connections, and at other locations shown on the drawings, and required for proper system operation and maintenance.

2.4 DIELECTRIC FITTINGS

A. Dielectric insulating fittings shall be provided to connect dissimilar metals, such as copper tubing to ferrous metal pipe. Connections 2" and smaller shall be threaded dielectric union conforming to ANSI B16.39. Connections 2-1/2" and larger shall be flange union with dielectric gasket and bolt sleeves, conforming to ANSI B16.42. Insulating fittings will not be required between bronze valves and copper piping, unless otherwise specified.

2.5 PIPE HANGERS AND SUPPORTS

A. All piping shall be rigidly supported from the building structure by means of hanger assemblies properly selected and sized for the application in accordance with the manufacturer's recommendations and specifications. Pipe hangers shall be Grinnell, B-Line, Erico, or equivalent.

B. No attempt has been made to show all required piping supports in all locations, either on the drawings or in the details. The absence of pipe supports and details on any drawing shall not relieve the Contractor of the responsibility for furnishing and installing proper hangers and supports throughout.

C. Piping hangers shall be spaced on the scheduled maximum spacing and shall have hangers not more than one foot from each elbow and other changes in direction or elevation. Provide additional hangers and supports at valves, strainers, in-line pumps adjacent to flexible connections, and other required heavy components. Piping system shall be installed in an approved manner and shall not overload the building structural frame. Contractor shall provide additional hangers and miscellaneous steel supports as may be required to distribute the piping system load over multiple structural members where required or directed. Maximum allowable spacing for steel and copper piping, other than fire protection piping, shall be as scheduled in Table No. 1.

TABLE NO. 1

MAXIMUM SUPPORT SPACING FOR STEEL
AND COPPER PIPING SYSTEMS

Steel Piping	- Maximum Spacing
1/2"	- 5'-0"
3/4" and 1"	- 6'-0"
1-1/4" through 2"	- 8'-0"
2-1/2" through 6"	- 10'-0"
8" through 12"	- 12'-0"

Copper Piping	- Maximum Spacing
1/2"	- 5'-0
3/4" through 2"	- 6'-0"
2-1/2" through 4"	- 8'-0"
5" and larger	- 10'-0"

D. Round rods supporting the pipe hangers shall be of the minimum dimensions as scheduled in Table No. 2. Hanger rods shall be hot-rolled steel, ASTM A-36 or A575, galvanized, all-thread. Provide for controlling level and slope by turnbuckles or other approved means of adjustment and incorporate locknuts.

TABLE NO. 2

HANGER ROD SIZE FOR PIPE HANGER SUPPORTS

1/2" to 2" pipe	- 3/8" rod
2-1/2" to 3" pipe	- 1/2" rod
4" to 5" pipe	- 5/8" rod
6" pipe	- 3/4" rod
8" to 12" pipe	- 7/8" rod
14" and 16" pipe	- 1" rod
18" and 20" pipe	- 1-1/4" rod
24" and 30" pipe	- 1-1/2" rod

E. Cast iron soil, waste and vent piping shall be provided with steel clevis type hangers. Grinnell Fig. 590 at each pipe joint and at each fitting.

F. Hanger spacing for plastic piping system support shall be as scheduled below in Table No. 3 for PVC and CPVC **and Table No. 4 for PVDF** piping, based on pipe full of liquid with specific gravity of 1.0. See Table No. 5 for specific gravity correction factors. Piping may be continuously supported with a "V" or "U" shaped support made of metal or heat resistant approved plastic material. Hanger supports shall be in accordance with piping system manufacturer's recommendations.

TABLE NO. 3A
MAXIMUM SUPPORT SPACING FOR PVC AND CPVC PIPING SYSTEMS

SCHEDULE 40 PVC - MAXIMUM SPACING
OPERATING TEMPERATURE (DEGREE F)

	PVC AND CPVC				CPVC			
Size	60 & less	80	100	120	140	160	180	200
1/2" and 3/4"	5.5	5	4.5	4	3	3	3	2.5
1" and 1-1/4"	6	5.5	5.5	4.5	3.5	4	3.5	3
1-1/2" and 2"	6	6	5.5	4.5	3.5	4.5	4	3.5
2-1/2" and 3"	7.5	7	6.5	5.5	4.5	5.5	5	4
4"	8	7.5	7	6	4.5	6	5.5	4.5
5" and 6"	8.5	8	7.5	6.5	5	7	6	5
8"	9.5	9	8.5	7	5.5	7.5	6.5	5.5
10"	10	9	8.5	7	5.5	--	--	--
12"	10.5	10	9	8	6	--	--	--

TABLE NO. 3B
MAXIMUM SUPPORT SPACING FOR PVC AND CPVC PIPING SYSTEMS

SCHEDULE 80 PVC - MAXIMUM SPACING
OPERATING TEMPERATURE (DEGREE F)

	PVC AND CPVC				CPVC			
Size	60 & less	80	100	120	140	160	180	200
1/2"	6	6	5.5	4.5	3.5	3	2.5	2
3/4"	6.5	6	5.5	5	3.5	3	2.5	2
1" and 1-1/4"	7	6.5	6	5	4	3.5	2	2.5
1-1/2" and 2"	7.5	7	6.5	5.5	4	4	3.5	3
2-1/2" and 3"	8.5	8	7.5	6.5	5	4.5	4	3
4"	9.5	9	8.5	7	5.5	5.5	5	3.5
5" and 6"	10	9	8.5	7	5.5	6	5.5	4
8"	11.5	11	10	8.5	6.5	6.5	6	4.5
10"	12.5	12	11	9.5	7	--	--	--
12"	13.5	13	12	10	8	--	--	--

TABLE NO. 4
MAXIMUM SUPPORT SPACING FOR PVDF PIPING SYSTEMS

SCHEDULE 80 PVDF - MAXIMUM SPACING
OPERATING TEMPERATURE (DEGREE F)

Size	70 & less	100	140	180	200	250
1/2"	3	3	2.5	2.5	2	2
3/4"	3	3	3	3	2.5	2.5
1"	3.5	3	3	3	2.5	2.5
1-1/4"	4	3.5	3.5	3	3	3
1-1/2"	4.5	4	4	3.5	3.5	3
2"	5.5	5	4.5	4	3.5	3.5
2-1/2"	5.5	5	4.5	4.5	4	3.5
3"	5.5	5.5	5	4.5	4	4
4"	6	6	5.5	5	5	4.5

TABLE NO. 5
SPECIFIC GRAVITY CORRECTION FACTOR FOR PLASTIC PIPING SYSTEMS

Specific Gravity:	1.0	1.1	1.2	1.4	1.6	2.0	2.5
Correction Factor:	1.0	0.98	0.96	0.93	0.90	0.85	0.80

G. Fire protection system shall be supported in strict accordance with the requirements contained in the applicable NFPA pamphlets and as specified in Division 21, Fire Suppression Systems.

H. Hangers, clamps and other support materials in contact with copper piping shall be copper or copper plated to prevent electrolysis. Hangers for copper piping shall be copper plated adjustable ring type Grinnell Fig. CT-269, adjustable swivel ring, Grinnell Fig. CT69, Fig. CT-65 or adjustable clevis type or equivalent. Provide minimum 10 mil plastic wrap around copper pipe at any ferrous point of attachment including trapeze hangers, clamps, and other supports.

I. Hangers for steel shall be steel clevis type hangers, Grinnell Fig. 260 or equivalent.

J. Where piping is installed side by side, the Contractor may support the piping utilizing trapeze type hanger assemblies. Horizontal trapeze member shall be galvanized steel channel, not less than 1-1/2" x 1-1/2" x 12" gauge, or Unistrut. Contractor shall provide heavier steel members as required for the load to be supported and the distance span. Trapeze hangers shall not be utilized for fire and sprinkler piping and [plumbing drain waste and vent piping. Hanger rods shall be as specified above, properly sized for the load supported but not less than 5/8" diameter. Un-insulated copper piping shall be isolated from the steel trapeze. Individual pipe shall be guided on the horizontal member at every other hanger point with 1/4" U-bolt fabricated from steel rod. Provide full circle galvanized sheetmetal insulation shield for insulated piping at trapeze hangers with U-bolt guide and galvanized sheetmetal insulation half-shield at other trapeze hangers. Insulation shield shall be 18 gauge minimum, Grinnell Fig. 167 or equivalent.

K. Supports for special piping systems including glass piping, refrigeration piping shall be provided as recommended by the pipe manufacturer and as specified in the applicable Sections of this Specification.

L. Vertical piping shall be supported at each floor level by means of riser clamps, Grinnell Fig. 261 and Fig. G-121, Erico, copper clad for copper piping systems, or equivalent. Proper allowance for the expansion and contraction of the vertical risers shall be provided. Contractor shall submit shop drawings indicating proposed method for support and control of expansion and contraction of vertical piping.

M. The use of pipe hooks, chains, or perforated iron for pipe hanger supports will not be permitted.

N. All insulated piping systems specified in Section 22 0700, Plumbing Insulation and Section 23 0700, HVAC Insulation, shall be provided with individual hangers sized to encircle the insulation. Hangers for insulated domestic water piping and roof drain piping systems may be installed under the insulation. See applicable sections for insulation thickness requirements. The specified piping systems where supported by means of trapeze hangers shall not rest directly on the trapeze horizontal members. The insulation at hangers and trapeze hangers shall be protected by means of insulation shield, Grinnell Fig. 167, Erico, or equivalent. Grinnell Fig. 160, Erico, or equivalent, curved steel pipe saddle, shall be provided at roll hangers. Contractor shall provide section of high density calcium silicate insulation or thermal hanger shields as manufactured by Pipe Shields, Inc., or equivalent, at all insulation piping system hanger and support points for piping 1-1/2” or larger.

O. Attachment of piping hangers to the building structure shall be provided in a manner approved by the Architect**.** The Contractor shall provide concrete inserts in the building construction at the time the concrete is poured and hangers shall be attached to these inserts. Self-drilling expansion anchors, Federal Specification FF-S-325, may be used in concrete construction not less than 4" thick. Applied load shall not exceed manufacturer's approved ratings. Power driven fasteners may be used in existing concrete or masonry not less than 4" thick where approved by the Architect. Attachment to steel construction shall be by means of beam clamps Grinnell Fig. 131, Erico, C-clamps Grinnell Fig. 86, Erico, or equivalent may be utilized for attachment of light loads as approved by the Structural Engineer. Attachment to wood construction shall be by means of wood screws or lag bolts.

2.6 PIPE SLEEVES

A. Pipe sleeves in concrete and masonry construction, footings and beams shall be Schedule 40 black steel pipe through 10”, standard wall thickness for sizes 12” and larger, ASTM A 53, A 106, or A 120.

1. For sleeve installation below grade in cast in place concrete wall or floor and masonry construction, sleeves shall be GPT type WS sleeves with minimum 2” water-stop collar or equivalent. The sleeves shall be provided free of welding slag. The water stop collar shall be welded all around on both sides to the sleeve at the point on the sleeve that positions it at the midpoint of the wall. Sleeve shall be primed inside and outside with Sherwin Williams Water Base Red Primer, or approved equivalent.

B. Pipe sleeves in gypsum board construction shall be galvanized steel metal, minimum 24 gauge; round tube closed with welded longitudinal joint and flanges on both sides.

C. Pipe sleeves shall be furnished and set by the Contractor and they shall be responsible for their proper and permanent location. Piping will not be permitted to pass through footings, beams or ribs except with written consent of the Architect.

D. Pipe sleeves shall be installed and properly secured in place at all points where pipes pass through gypsum board stud walls, concrete, and masonry construction and at all fire and smoke rated walls and partitions.

E. Where insulated piping is installed, calcium silicate inserts to match the insulation thickness and extending 1" past the sleeve on both ends, shall be provided.

F. Sleeves shall be not less than 1" or more than 2" larger in diameter than the pipe to be installed.

G. Pipe sleeves in floors shall extend 2" above finished floor in chases and equipment room areas unless otherwise approved by the Architect. Openings between piping and sleeves shall be made watertight with plastic cement installed to a minimum depth of 2".

H. Un-insulated piping passing through fire walls, smoke wall, sound control walls and air plenum separations shall be sealed airtight to the adjacent construction by means of UL approved fire stop sealant materials.

I. Insulated piping passing through fire walls and smoke walls shall be provided with Calcium Silicate pre-formed pipe insulation of thickness to match adjacent piping, extending minimum 1-inch beyond sleeve in each direction.

1. For penetrations through concrete or masonry walls/floors, the space between the piping sleeve and insulation shall be sealed airtight with UL approved firestop sealant and packed with minimum 4” thickness mineral wool (minimum 4 pcf density) tightly packed and recessed to accommodate sealant.
2. For penetrations through gypsum board wall construction, both sides of the annular space between the insulation and sleeve shall be sealed with UL approved firestop sealant.

J. Penetrations of gypsum board sound walls and air plenum separators shall be caulked airtight with an approved UL firestop sealant.

2.7 PIPE SLEEVE SEAL SYSTEMS

A. Provide pipe sleeve seal systems by one of the following:

1. Link-Seal Modular Wall Penetration Seal as manufactured by GPT.
2. Metraflex Company
3. Proco Products, Inc.

B. Description: Modular sealing element unit, designed for field assembly, for filling annular space between piping 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: Plastic, reinforced nylon polymer
3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements.

C. Pipe sleeve seal system shall be utilized at all exterior wall penetrations.

D. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Provide and erect, according to the best practices of the trade, all piping shown on drawings and required for the complete installation of these systems. The piping shown on the drawings shall be considered as diagrammatic for clearness in indicating the general run and connections, and may or may not in all parts be shown in its true position. The piping may have to be offset, lowered or raised as required or as directed at the site. This does not relieve the Contractor from responsibility for the proper erection of systems or piping in every respect suitable for the work intended as described in the specifications. In the erection of all piping, it shall be properly supported and proper provisions shall be made for expansion, contraction and anchoring of piping. All piping shall be cut accurately for fabrication to measurements established at the construction site. Pipe shall be worked into place without springing and/or forcing, properly clearing all windows, doors, and other openings and equipment. Cutting or other weakening of the building structure to facilitate installation will not be permitted. All pipes shall have burrs and/or cutting slag removed by reaming or other cleaning methods. All changes in direction shall be made with fittings. All open ends of pipes and equipment shall be properly capped or plugged to keep dirt and other foreign materials out of the system. Plugs of rags, wool, cotton waste or similar materials may not be used in plugging. All piping shall be arranged so as not to interfere with removal and maintenance of equipment or filters or devices; and so as not to block access to manholes, access openings, etc. Flanges or unions as applicable for the type of piping specified shall be provided in the piping at connections to all items of equipment including refrigeration machines. All piping shall be so installed to ensure noiseless circulation. All valves and specialties shall be so placed to permit easy operation and access, and all valves shall be regulated, packed and adjusted at the completion of the work before final acceptance. All piping shall be erected to ensure proper draining. Water piping may be run level but shall be free from traps.

3.2 JOINTS

A. Caulked Joints: Caulked joints in hub-and-spigot piping and vent piping shall be packed firmly with white oakum, "Sealite No. 110," or hemp and caulked with pure molten lead not less than 1" deep. Resilient molded gasket joints or "Ty-Seal" may be used in lieu of lead and oakum for sanitary soil, waste and vent piping. No-hub pipe and fittings will be accepted with the exception that no-hub pipe and fittings shall not be allowed for buried installation.

B. Screwed Joints: Shall have American Taper pipe threads. Ream pipe ends and remove burrs after threading. Make up joints using Teflon tape or other approved compound applied to the male threads only.

C. Solder Joints: Copper tubing shall be cut square and burrs removed. Both inside of fittings and outside of tubing shall be well cleaned before sweating. Care shall be taken to prevent annealing of fittings and hard drawn tubing when making connections. Joints for sweated fittings shall be made with a non-corrosive paste flux and solid 95-5 tin-antimony wire solder, unless otherwise specified. Cored solder will not be permitted. 50/50 lead solder shall not be permitted for any applications.

D. Welded Joints: On black steel piping 2-1/2" and above in size, the joints may be welded. Welding shall be done using either gas or electric welding equipment. Certified welders shall be used. Welders shall be certified in accordance with Section IX of ASME Boiler and Pressure Vessel Code, latest edition. All pipe surfaces shall be thoroughly cleaned before welding. Each joint shall be beveled before being welded. Piping shall be securely aligned and spaced, and the width of circumferential welds shall form a gradual increase in thickness from the outside surface to the center of the weld. All fittings used in the welded piping systems shall be standard ASA fittings, and shall be of standard pipe thickness. The Contractor shall provide a fireproof mat or blanket to protect the structure and adequate fire protection at all locations where welding is done. The use of fittings formed from welded pipe sections will not be permitted.

E. Flanged Joints: Flanged joints shall conform to the American Standard for cast iron flanged pipe fittings, Class 125, 150 or 300 as specified in the applicable Sections of these specifications. Gaskets shall be full face or ring type, non-asbestos, suitable for the service on which used.

3.3 PUMP AND EQUIPMENT CONNECTIONS

A. All piping connecting to pumps and other equipment whether connected utilizing flexible connectors or with solid pipe connectors, shall be installed without strain at the pipe connection of the equipment. The Contractor shall be required, if so directed, to disconnect piping to demonstrate that piping has been so connected.

3.4 EXPANSION AND CONTRACTION

A. The Contractor shall make all necessary provisions for expansion and contraction of piping with offsets or loops and anchors as required to prevent undue strain. Contractor shall provide shop drawings for proposed method and arrangement for control of expansion and contraction of piping. See Section 23 0505 for expansion joints, expansion compensators, pipe guides and pipe anchors.

3.5 PROTECTIVE COATINGS

A. All underground steel pipe shall be wrapped with "Scotchwrap" No. 50 tape or equivalent, to give not less than two complete layers on the entire underground piping system, or piping shall have X-Tru-Coat factory applied plastic protective covering.

3.6 FLUSHING, DRAINING AND CLEANING PIPE SYSTEMS

A. The Contractor shall flush out all water systems with water before placing them in operation. Other systems shall be cleaned by blowing them out with compressed air or nitrogen. After systems are in operation and during the test period, all strainer screens shall be removed and thoroughly cleaned.

B. See applicable HVAC piping system specification sections for chemical cleaning of piping systems.

3.7 TESTING

A. Before any insulation is installed or before piping is covered or enclosed, all piping systems shall be tested and proven tight at not less than 150% of the maximum service pressure which the piping systems will be required to handle. Piping system tests shall be as specified in the applicable sections of this Specification. All tests shall be witnessed and approved by the Architect.

B. All labor, material, and equipment required for testing shall be furnished by the Contractor. The Contractor shall be responsible for all repairs and retesting as required. All instruments and other equipment whose safe pressure range is below that of the test pressure shall be removed from the line or blanked off before applying the tests. To perform tests, all lines shall be flushed and cleaned.

C. All safety measures required by codes or ordinances or reasonably applicable to the situation shall be provided by the Contractor in conjunction with the testing of the piping systems.

D. Equipment or piping to be pressure tested shall not be insulated, covered, or concealed prior to that test. Underground piping may be partially backfilled prior to pressure test when required for application of the test except that joints shall remain exposed until after the test. Tie rods, clamps etc., shall be in place and fastened.

E. Tests shall not be used to establish pressure ratings.

F. Protect all piping and equipment against over pressure, collapse from vacuum, and hydraulic shock during the filling, testing and draining procedures. Seats of iron valves shall not be subjected to a pressure in excess of the maximum cold working pressure of the valve. Pressure tests against other closed valves shall not exceed twice the normal rating.

G. Apply test pressure only after the system and test medium are at approximately the same temperature, preferably not less than 60^0F. Note that some applicable codes may require testing above a specified minimum temperature.

H. Remove from the system all pumps, turbines, traps, expansion joints, instruments, control valves, safety valves, rupture discs, orifice plates, etc., which might be damaged by the test. Also remove all items such as orifice plates which might trap air in a system to be hydrostatically tested. Disconnect all instruments and air lines where copper tubing starts.

I. Systems may be separated into sub-systems for testing if such action will expedite or simplify the testing.

J. During hydrostatic testing of lines, provide temporary supports to prevent overstressing supports or hangers. When tests are completed, remove all temporary supports, locks, stops, etc., and adjust supports for their cold load and alignment.

END OF SECTION 230504

SECTION 230505 - PIPING SPECIALTIES

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Furnish and install all piping specialties necessary for satisfactory operation of the systems. Conform to applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

B. Lead Ban: All systems and system components, pipe, fittings, and fixtures delivering water for human consumption shall be lead free.

1. Any product designed for dispensing potable water shall meet both the NSF 61 and NSF 372 test standards via third-party testing and certification.
2. Lead free refers to <0.25% weighted average lead content in relation to wetted surface of pipe, fittings, and fixtures in systems delivering water for human consumption, and solder and flux which does not contain more than 0.2% lead.

1.2 RELATED SECTIONS

A. Section 23 0500, Common Work Requirements.

B. Section 23 0504, Pipe and Pipe Fittings.

C. Section 23 0523, Valves.

1.3 SUBMITTAL DATA

A. Furnish complete submittal data for all piping specialties including manufacturer’s specifications, performance characteristics, ratings, installation instructions, certifications and approval of listing agencies, wiring diagrams, and selection analysis.

PART 2 - PRODUCTS

2.1 STRAINERS

A. Strainers suitable for the application shall be furnished and installed on the high pressure side of pressure reducing valves, pressure regulating valves, suction side of pumps, inlet of indicating and control instruments and equipment subject to sediment damage, and as shown on the drawings. Strainers shall be "Y"-type unless basket strainers are indicated. Tee-type strainers will not be accepted. Strainer element shall be removable without disconnecting piping. Screens shall be Type 304 stainless steel with 1/8 inch perforations for water service. Every strainer shall be provided with a blow-off connection not less than 1/2" NPT and provided with a ball valve the full size of the

strainer outlet tapping. Strainers located outside of mechanical equipment rooms and above ceilings shall be provided with hose connection and cap on the outlet of the blowoff valve. Strainers shall be Spirax Sarco, Armstrong, Febco, Grinnell, Hoffman, Keckley, Metraflex, Mueller, Yarway, or equivalent.

B. Strainers 2" and under for copper piping systems shall be threaded connection, bronze body, 250 PSIG maximum working pressure, suitable for steam, oil, gas and liquid service, Sarco BT or equivalent.

C. Strainers 2" and under for steel piping systems shall be threaded connection, bronze body, as specified above or cast iron body as specified herein, except all strainers in galvanized steel domestic water systems shall be bronze body. Cast iron strainers shall be threaded connection, 250 PSIG maximum working pressure, suitable for steam, oil, gas and liquid service, Sarco IT or equivalent.

2.2 PRESSURE GAUGES

A. 2.5-inch glycerin filled, SS case, 1.5% accuracy, dual scale (PSI & KPA), bronze bourdon tube and 0.25-inch NPT connection, brass snubber with properly selected filter disc for the application, and needle valve with knurled brass or ABS plastic handle. Provide multiple needle valves where a single pressure gauge is used to measure pressure at multiple points. Provide siphon for steam gauges. Winters, Weiss, Marshalltown, Ashcroft, Trerice, Weksler, or equivalent.

B. Select pressure range as indicated on the drawings, or if not indicated select so that the normal operating pressure is approximately 50% of the scale range. Provide compound and vacuum gauges where required by the application.

C. Install gauges so they are easily readable from normal operator level. Where the sensing location is not convenient to the operator, install the gauge and needle valves at a location easily read from normal operator level, extend piping from there to the sensing point on the main pipe, and provide a ball valve for isolation at the main. In addition, provide drain and vent valves to facilitate removing air and water from the sensing line.

2.3 THERMOMETER AND THERMOMETER WELLS

A. Either liquid filled or digital type, vari-angle, 3-1/2" stem for pipe sizes through 6" and 6" stem for pipe sizes 8" and larger, dual scale (degrees F & C), separable brass socket, extension neck where installed in insulated piping, and accuracy 1% of range. Winters, Weiss, Moeller, Trerice, Weksler, Duro, or equivalent.

1. Liquid Filled Type: 9" case, straight form, V-shaped, high pressure die cast aluminum, baked enamel finish, with heavy glass-protected front firmly secured with spring action, and organic liquid filled magnifying lens. Winters 9IT or approved equal.
2. Digital Type: May be used both indoors or in outdoor locations not exposed to sunlight, high impact ABS plastic housing, suitable for operation at 16 Lux. Winters 9IT or approved equal.

B. Ranges: Provide the following ranges except where otherwise indicated:

Domestic Cold Water	0-120 degrees F
Domestic Hot Water	30-180 degrees F

2.4 MANUAL AIR VENTS

A. Provide manual air vents at locations indicated on the drawings, at the high point of all liquid piping system and as otherwise required for proper air elimination and liquid circulation.

B. Manual air vents shall be 1/2" brass ball valves as specified in Section 23 0523. Provide brass hose connection and plug on valve outlet.

2.5 AUTOMATIC AIR VENT

A. Provide automatic air vents for all separators, at the high point of all hydronic systems and at locations indicated on the drawings. Automatic air vents shall be 3/4" size, minimum. Provide manual shut-off ball valve between automatic air vent and piping system. Automatic air vents shall be float type, 150 PSIG maximum working pressure, 3/4" NPT system connection, Amtrol Model No. 720, Taco, Armstrong, Watson-McDaniel, Hofmann, or equivalent.

2.6 MANUAL DRAIN VALVES

A. Provide manual drain valves at locations indicated on the drawings, at the low points of all liquid piping systems, and as otherwise required for proper draining of systems. Manual drain valves shall be sized as shown on the drawings but not less than 3/4" size, brass ball valve, as specified in Section 23 0523. Pipe discharge from drain valves to floor drain, floor sink, or as otherwise directed for indirect discharge into sanitary sewer system. For drain valves located above ceiling or in location outside mechanical equipment areas provide brass hose connection and cap for valve discharge.

2.7 TEMPERATURE AND PRESSURE TEST PLUGS

A. 0.25 or 0.5-inch NPT with brass body, EPDM core, and brass gasketed cap. Winters, Peterson, or approved equal. Supply one pressure/temperature test kit with two 4" Duro #105 pressure gauges of 1% accuracy and ranges as required by application; and two 2" Tel-Tru #39R Bi-metal thermometers with 8" stem, 1% accuracy, and ranges as required by the applications; and a protective carrying case.

2.8 FLEXIBLE CONNECTORS

A. Furnish and install flexible connectors at locations indicated on the drawings and at all piping connections associated with equipment mounted on or hung from vibration isolators. Flexible connectors shall be constructed of multiple ply nylon cord fabric and neoprene, operating pressure

150 PSIG at 220^{O}F through 12" size. Provide butyl or Hypolon liner and applications with fluid temperatures in excess of 225^{O}F.

B. Flexible connectors shall be single or twin sphere with Class **[150] [300]** flange connections for sizes 2-1/2" and larger and threaded connections with galvanized female unions for sizes 3/4" through 2". Mason Industries MFTCR, Hyspan, Metra-Flex, Keflex, Proco, or equivalent. Flexible connectors required for outdoor installation shall be braided stainless steel type.

C. Installation of flexible connectors shall be in strict accordance with manufacturer's recommendations. Spacing between piping system flanges shall be based on the flexible connector's expanded length corresponding to the system's operating pressure. Control rods or cables shall be provided for units installed in unanchored applications where system operating pressure and dynamic forces exceeds manufacturer's recommendations for unrestrained installations.

2.9 EXPANSION TANK

A. Furnish and install diaphragm type, pre-pressurized, ASME code construction 125 PSIG working pressure, expansion tank in horizontal or vertical arrangement as shown on the drawing and required for equipment space allocation. Properly sized expansion tanks shall be provided for all closed circuit hydronic systems. Connect expansion tank to the low pressure side of the piping system with 3/4" minimum line size; provide quarter turn ball valve with handle removed for manual isolation valve. Contractor shall field verify expansion tank air charge and re-charge as required to maintain correct system pressurization and tank expansion volume. Expansion tanks shall be Amtrol, Woods, Armstrong, Taco, or equivalent.

2.10 WATER PRESSURE REGULATING VALVES

A. Furnish and install water pressure regulating valves, Watts U5B, Bell & Gossett, Amtrol, Cash, Jordan, or equivalent, 3/4" size minimum for water makeup to all hydronic systems and at other locations as shown on the drawings. Water pressure regulating valves shall be brass body, union inlet with integral strainers, 300 PSIG maximum working pressure, with built-in thermal expansion bypass.

B. For high water capacity applications provide Watts 2235B, Bell & Gossett, Amtrol, Cash, Jordan, or equivalent.

C. Provide high or low pressure range depending on application requirements. Set pressure shall be as shown on the drawings, or as required to provide a minimum system pressurization of 12 PSIG at the system's highest point for closed circuit hydronic systems, or as recommended by equipment manufacturers.

2.11 WATER PRESSURE RELIEF VALVES

A. Furnish and install ASME labeled, National Board Stamped, water pressure relief valves, Watts Series 174A or 740, Bell & Gossett, Amtrol, Cash, Jordan, or equivalent, 3/4" size minimum for relief of all water makeup to all closed circuit hydronic systems. Properly sized relief valves shall be provided where required for over-pressure protection on heat exchangers, converters, boiler, and pressure vessels, and other locations as shown in the drawings.

B. Relief valves shall be sized for the full system heating capacity, to match the makeup capacity, or as otherwise required to protect the system from over-pressure conditions. Relief valves shall be factory pre-set for maximum pressure rating shown in the drawings, or for approximately 125% of the system operating pressure, but in no case shall the relief valve setting exceed the maximum safe operating pressure of the system and system components and equipment.

2.12 WATER TEMPERATURE AND PRESSURE RELIEF VALVES

A. Furnish and install ASME labeled, National Board stamped water temperature and pressure relief valves, Watts, Cash, or equivalent, for all domestic water heaters, domestic water storage tanks, and other locations indicated in the drawings.

B. Water temperature and pressure relief valves shall be sized for the full system heating capacity at 210^{o}F maximum operating temperature and shall be furnished with the required valve thermostat tube extension length.

2.13 WATER REDUCED PRESSURE BACKFLOW PREVENTERS

A. Division 33, for backflow protection associated with site water supply system.

B. Backflow protection devices associated with landscaping and irrigation systems shall be furnished and installed under the Site Work sections of these specifications.

2.14 SOLENOID VALVES

A. Furnish and install electric solenoid valves as shown on the drawing and as required for the operation of the mechanical systems. Solenoid valves shall be 115 volt single phase, 60 Hz, two-way arrangement, two positions with normally open or normally closed arrangement as required of the application. Solenoid valves associated with safety protection of systems including freeze-protection, drain down, etc. shall be provided such that in the event of a power failure the system shall fail to a safe operating condition. Solenoid valves shall be as manufactured by ASCO, Armstrong, Honeywell, Metrex, or equivalent.

B. See Section 23 0500, Common Work Requirements, and Section 23 0549, HVAC and Electrical Installation Coordination, for requirements associated with electrical control and power wiring for solenoid valves. Furnish hazardous duty enclosure where required by the application.

2.15 FLOW SWITCHES

A. Furnish and install flow switches where required for protection and/or monitoring of mechanical equipment including water chillers, boilers, pumps, etc. and as otherwise shown on the equipment schedule, and the drawings.

B. Flow switches shall be either paddle type or differential pressure type as required by the application and as shown on the drawings, except differential pressure type flow switches shall be utilized for

water chillers and other applications where minor pressure fluctuation could cause nuisance tripping of equipment operation.

1. Paddle type flow switch shall be McDonnell and Miller Model FS7-4 Series, or equivalent designed for industrial duty, brass body and trim, 300 PSIG maximum working pressure, paddle size as required for application, single pole double throw switches, with electrical rating of 7.4 full load amps at 115 VAC. Provide hazardous duty enclosure where required by the application. Flow switches shall be installed in a horizontal pipe with inlet and outlet conditions necessary to provide trouble-free operation.
2. Differential pressure flow switch shall be Honeywell Model 406 Series or equivalent, adjustable pressure differential setting, dustproof mercury switch enclosure, 1/4" NPT bellows connections, single pole, single throw switch, with electrical rating of 7.2 full load amps at 115 vac. Differential pressure switches shall be properly supported on the equipment controlled or wall mounted adjacent to the equipment or piping system.

2.16 PIPE ANCHORS

A. Pipe anchors shall be constructed of welded steel as detailed on the drawings.

B. Pipe anchors shall be arranged as shown on the drawings and as required to properly control/piping system expansion and contraction in conjunction with system flexibility due to off-sets, bends, and loops and expansion joints and compensators.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All specialties shall be installed in accordance with the best standard practices and as recommended by the manufacturer.

B. Install thermometers so they are easily readable from operator level.

C. Where thermometers, gauges, vents and test fittings occur in insulated piping systems or on insulated equipment, extension necks shall be provided to extend beyond the insulation.

3.2 AIR VENTS

A. Manual air vents shall be installed as specified herein and at the high points in all piping systems.

B. Automatic air vents shall be installed as specified herein and at locations indicated on the drawings. Automatic air vents shall be installed level and in accordance with manufacturer's directions to properly vent system, complete with individual isolation valves.

3.3 STRAINERS

A. All strainer screens, including basket strainers and suction diffusers, shall be removed and cleaned

prior to commencing testing and balancing work and shall be maintained clean through project final acceptance by the Owner. Suction diffuser start-up strainers shall be removed prior to final system testing and balancing work.

3.4 TEST AND ADJUSTMENT

A. Field adjust all water pressure regulating valves, and specialties to provide required system operation.

B. Field test and verify the operation of all safety devices including water relief valves and temperature and pressure relief valves.

3.5 RELIEF VALVE DISCHARGE

A. Water pressure relief valve and water temperature and pressure relief valve discharges shall be piped full size to the outside of the building or discharged indirectly in a properly sized building floor drain or floor sink, and as allowed by the Building Mechanical and Plumbing Codes. When the operating discharge temperature is in excess of 212^{o}F, the discharge shall be equipped with a splash shield or centrifugal separator.

B. Water reduced pressure backflow preventer discharge shall be piped full size to the outside of the building or discharged indirectly into a properly sized building floor drain or floor sink as allowed by the Building Mechanical and Plumbing Codes. Provide a bronze air gap funnel with stainless steel fasteners for installation under reduced pressure backflow prevention relief valve. Febco Model AGD or equivalent, 1" discharge pipe size for backflow preventer size through 2".

END OF SECTION 230505

SECTION 230523 - VALVES

PART 1 - GENERAL

1.1 REQUIREMENTS

A. All Valves shall conform with current applicable provisions of the General Conditions, Supplemental General Conditions, and General Requirements.

B. All Valves shall meet the current MSS Specifications covering Bronze & Iron Valves. MSS-SP-80, MSS-SP-70, MSS-SP71, MSS-SP-85 where applicable.

C. Lead Ban: All systems and system components, pipe, fittings, and fixtures delivering water for human consumption shall be lead free.

1. Any product designed for dispensing potable water shall meet both the NSF 61 and NSF 372 test standards via third-party testing and certification.
2. Lead free refers to <0.25% weighted average lead content in relation to wetted surface of pipe, fittings, and fixtures in systems delivering water for human consumption, and solder and flux which does not contain more than 0.2% lead.

1.2 RELATED SECTIONS

A. Section 23 0500 for Common Work Requirements for HVAC.

B. Section 23 0523 for Valve Identification.

C. Section 23 0504 for Pipe and Pipe Fittings.

D. Section 23 2313 for Refrigerant Piping System.

E. Division 21 for fire suppression system valves and tamper switches.

F. Division 22 for plumbing system.

1.3 SCOPE

A. Contractor shall furnish and install all valves and accessories necessary for satisfactory operation of the systems.

1.4 VALVE REQUIREMENTS

A. All Gate, Globe, Check, Ball valves shall be manufactured by Milwaukee, Nibco, Apollo, Stockham, Powell, Crane, Tyco-Grinnell, or equivalent.

B. All lubricated plug valves shall be as manufactured by Rockwell, Walworth, Homestead, or equivalent.

C. Butterfly valves shall be as manufactured by Milwaukee, W. C. Norris, Centerline, Crane, Demco, Keystone, Tyco-Grinnell, Victaulic, Nibco, or Dezurik, or equivalent. Butterfly valves may be used for closed circuit chilled water, heating hot water (200^{o}F maximum) run-around coil and heat pump circulating water systems and for condensing water systems. Butterfly valves shall not be used for domestic water or other non-specified service.

D. Ball valves shall be utilized in lieu of gate valves and globe valves for all HVAC and plumbing systems for sizes 2" and smaller.

E. All valves furnished under Division 22 and 23**,** of the same type, shall be products of a single manufacturer.

F. Provide gate and globe valves with packing that can be replaced with the valve under full working pressure.

PART 2 - PRODUCTS

2.1 GENERAL SERVICE VALVES, HVAC AND PLUMBING SYSTEMS

A. Gate Valves - 2-1/2" and Larger, Class 125: Valves 2-1/2" and larger shall be of ASTM A-126 Class B cast iron, flanged ends, Class 125 construction, OS & Y Type, rising stem, bronze trim, non-asbestos packing. Milwaukee F2885 or equivalent.

B. Gate Valves - 2-1/2" and Larger, Class 250: Valves 2-1/2" and larger shall be of ASTM A-126 Class B cast iron, flanged ends, Class 250 construction, OS & Y Type, rising stem, bronze trim, non-asbestos packing. Milwaukee F2894 or equivalent.

C. Globe Valves - 2-1/2" and Larger, Class 125: Valves 2-1/2" and Larger shall be of ASTM A-126, Class B cast iron, flanged ends, Class 125 construction, bolted bonnet, gland packed, non-asbestos packing. Milwaukee F2981M or equivalent.

D. Globe Valves - 2-1/2" and Larger, Class 300: Valves 2-1/2" and larger shall be of ASTM A-126, Class B cast iron, flanged ends, Class 300 construction, bolted bonnet, gland packed, non-asbestos packing. Milwaukee F2983 or equivalent.

E. Check Valves - 2" and Smaller, Class 125: Valves 2" and smaller shall be cast of ASTM B-62 bronze, Class 125 construction, Y-pattern, swing type design, teflon seat, disc for steam service, Buna-N for water service. Milwaukee 509 (Threaded) or equivalent; Milwaukee 1509 (Solder) or equivalent.

F. Check Valves - 2" and Smaller, Class 150: Valves 2" and smaller shall be cast of ASTM B-62 bronze, Class 150 construction, Y-pattern, swing type design, bronze seat, composition disc, teflon seat disc for steam service, Buna-N for water service. Milwaukee 510 (Threaded) or

equivalent; Milwaukee 1510 (Solder) or equivalent.

G. Check Valves - 2" and Smaller, Class 300: Valves 2" and smaller shall be cast of ASTM B-62 bronze, Class 300 construction, Y-pattern, swing type design, bronze regrinding disc. Milwaukee 507 (Threaded) or equivalent.

H. Check Valves - 2 1/2" and Larger, Class 125: Valves 2-1/2" and larger shall be of ASTM A-126 Class B, cast iron, flanged ends, Class 125 construction, bolted bonnet, bronze trim, swing type design. Milwaukee F2974M or equivalent.

I. Check Valves - 2 1/2" and Larger, Class 250: Valves 2-1/2" and larger shall be of ASTM A-126 Class B, cast iron, flanged ends, Class 250 construction, bolted bonnet, bronze trim, swing type design. Milwaukee F2970 or equivalent.

2.2 BUTTERFLY VALVES

A. Valves 2-1/2" and larger shall be full lug pattern, ASTM A-126, Class B cast iron body, 416-SS stems, aluminum/bronze disc, EPDM liner and seats (-30°F to 275°F) w/rigid phenolic cartridge, 200 PSIG working pressure with Bubble tight shut-off. Valves shall be for mounting between flanges with lugs drilled and tapped so that pipe may be disconnected on either side of valve with opposite end remaining under pressure. Milwaukee ML-123-E or equivalent.

B. Valves 4" and smaller shall be provided with level handler operator with spring loaded lock stops. Valves 5" and larger shall be furnished with manual gear operator with hand wheel.

C. Valves installed for insulated services shall be provided with extensions, as required, such that operator does not interfere with insulation or insulation jacketing.

D. Butterfly valves furnished for use in grooved piping system shall meet the material specification requirements as specified herein.

2.3 BALL VALVES

A. Valves 2" and smaller shall be cast of ASTM B-62 bronze, Class 150 construction, 600 PSI W.O.G. Two-piece body, chrome plated ball, blowout proof stem, reinforced TFE seats, non-asbestos packing. Milwaukee BA-100 (threaded) or equivalent. Milwaukee BA-150 (solder) or equivalent.

B. Valves installed on insulated services shall be provided with extensions, as required, such that operator does not interfere with insulation or insulation jacketing. Cutting or notching of the insulation or bending of handles shall not be permitted.

2.4 NATURAL GAS VALVES

A. Valves 3/4" and Smaller: Bronze natural gas cock, Walworth No. 590 (square head), Walworth 591 (flat head) or equivalent.

B. Valves 3" and Smaller: Ball valve shall be cast of ASTM B-584 bronze, Class 250 construction, threaded connections, chrome plated big ball and stem, RDTFE seat and stem packing, blow-out proof stem, UL Listed for natural gas service, Apollo 80-100 Series or equivalent.

C. Valves 4" and Larger: Lubricated plug valve, cast iron construction, 175 PSIG W.O.G., threaded connection for valves 2" and smaller, Class 125 Flange connections, level handle operator. Walworth No. 1797F (Flanged) or equivalent.

2.5 MANUAL AIR VENTS AND DRAIN VALVES

A. For manual air vents and drain valves, see Specification Section 23 0505, Piping Specialties.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All valves shall be installed in locations which will allow easy operation and facilitate maintenance.

B. Gate and Globe valves shall be installed with stems horizontal.

END OF SECTION 230523

SECTION 230548 - VIBRATION AND SEISMIC CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with the applicable provisions of the General Conditions, Supplemental General Conditions, and General Requirements.

1.2 RELATED SECTIONS

A. Section 23 0500, Common Work Requirements for HVAC.

B. Section 23 0504, Pipe and Pipe Fittings.

1.3 SCOPE

A. It shall be understood that the requirements for seismic restraints are in addition to other requirements as specified elsewhere for the support and attachment of equipment and mechanical services, and for the vibration isolation of same equipment. Nothing on the project drawings or specifications shall be interpreted as justification to waive the requirements for seismic restraint as specified herein, shown on the drawings and required by Code.

B. The work under this section shall include furnishing all labor, materials, tools, appliances and equipment, and performing all operations necessary for the complete execution of the installation of seismic snubber restraint assemblies as shown, detailed and/or scheduled on the drawings and/or specified in this section of the specifications.

C. The materials and systems specified in this section shall be provided by the Contractor from a single Seismic Snubber Restraint Materials Manufacturer to assure sole source responsibility for the performance of the seismic restraints used.

D. The seismic snubber restraint materials manufacturer shall be responsible for detailed design for seismic supports, including calculation for size and attachment, signed and sealed by registered State of New Mexico Structural Engineer.

1.4 SUBMITTALS

A. See Section 23 0500 for general requirements for submittal materials. In addition to the requirements contained in Section 23 0500, provide submittal information for all products and materials covered under this Section of the Specifications as listed herein.

B. Furnish complete catalog data on all vibration isolators, restraints, and equipment vibration bases to be utilized for the project in order to establish compliance with the plans and specifications and all code requirements.

C. Furnish complete shop drawing information including construction details for all vibration bases; support points and anchor bolt requirements and locations; method of support for piping and ductwork; method of isolation for piping and ductwork passing through the building structure; and location and arrangement of seismic restraints.

D. Manufacturers not listed as approved in 'Part 2 - Products' of this section must submit for prior approval in accordance with provisions contained in Section 23 0500.

E. Drawings shall be reviewed and certified by a registered Professional Engineer, with a minimum of five (5) years working experience in this field, certifying that the submitted seismic restraint system design and anchorage details complies with all specification requirements and applicable codes.

1.5 CODE REQUIREMENTS

A. Seismic restraints shall be provided for equipment, materials and systems furnished and installed under Division 23 of this Specification in accordance with the requirements of the 2006 International Building Code; and NFPA No. 13 for fire protection system as adopted and interpreted by the State of New Mexico and the City of Lovington, for Seismic Zone ____ and for 'Critical Facilities'.

1.6 SEISMIC RESTRAINT REQUIREMENTS

A. The Contractor shall submit calculations prepared by a State of New Mexico licensed Structural Engineer to substantiate that all items of mechanical equipment, ductwork and piping systems are properly supported to resist earthquake forces as required herein.

B. All mechanical equipment mounted on vibration isolators shall be provided with seismic restraints securely anchored to the building structure capable of resisting horizontal forces of 100% of their weight and/or in accordance with IBC Requirements for Seismic Zone ___.

C. All items of mechanical equipment required for life safety including the fire pump and fire protection systems shall be provided with seismic restraints securely anchored to the building capable of resisting horizontal forces of 100% of their weight and/or in accordance with IBC Requirements for Seismic Zone ____.

D. All items of mechanical equipment, except as specified above, and all piping and ductwork furnished and installed under Division 23 shall be provided with seismic restraints securely anchored to the building capable of resisting horizontal forces of 50% of their weight.

E. Seismic restraint/snubber manufacturer shall be responsible for the structural design of attachment hardware as required to attach seismic restraints/snubbers to both the equipment and supporting structure on vibration isolated equipment, or to directly attach equipment to the building structure for non-isolated equipment.

F. The Contractor shall furnish a complete set of approved shop drawings of all mechanical and

electrical equipment which is to be restrained to the seismic restraint manufacturer, from which the selection and design of seismic restraint devices and/or attachment hardware will be completed. The shop drawings furnished shall include, at a minimum, basic equipment layout, length and width dimensions, installed operating weights of the equipment to be restrained and the distribution of weight at the restraint points.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

A. Floor mounted vibration isolators shall be either spring isolators designed for seismic restraint application or pre-compressed molded fiberglass or ribbed neoprene units as specified herein and in the Mechanical Equipment Schedule on the drawings. All vibration isolated equipment shall employ seismic snubbers having an approved "R" rating issued by the State of New Mexico.

B. Hanger type vibration isolators shall consist of steel springs in series with neoprene element as scheduled and specified on the drawings.

C. All vibration isolation devices shall be furnished by a single manufacturer to assure sole source responsibility for the proper performance of the materials used.

D. Vibration isolators shall be provided to maintain a minimum of 1-inch operating clearance.

E. Vibration isolators shall have a minimum static deflection as specified on the drawings. Isolators shall be selected by the manufacturer for non-resonance with the equipment forcing frequency and the building structure's natural frequencies. Isolators shall be provided for suitable mounting to equipment and supporting structure.

F. Vibration isolators shall be furnished by Kinetics Noise Control, Mason, or equivalent.

2.2 EQUIPMENT BASES

A. Vibration isolation bases shall be supplied by the vibration isolation manufacturer as indicated on the drawings and as required for the application. Concrete for inertia bases shall be furnished and installed by the Contractor and shall comply with Division 3 requirements.

B. Structural steel bases shall be designed and supplied by the isolator manufacturer. Kinetics Noise Control Type SFB, or equivalent. Bases shall be designed with isolator brackets to reduce the mounting height of the equipment. To assure adequate stiffness, the height of the members shall be a minimum of 8% of the longest span between isolators, or at least 6 inches. Where thinner sections are necessary, due to head room limitations, etc., the section modules of the members selected shall equal or exceed the section modules of wide flange steel members whose thickness is 8% of the longest span between isolators.

C. Reinforced concrete inertia bases shall be designed by the isolation manufacturer who shall furnish the steel framework, Kinetics Noise Control, CIB, or equivalent. The Contractor shall furnish and install concrete, poured into the welded steel frame. The steel framework shall incorporate pre-

located equipment anchor bolts, 1/2" diameter reinforcing bars on nominal 8" centers each way, and recessed isolator mounting brackets to reduce the mounting height of the equipment, but yet remain within the confines of the base. The thickness of the base shall be a minimum of 8% of the longest span between isolators, at least 6", or as indicated on the drawings. Where inertia bases are used to mount pumps, the bases shall be wide enough to support piping elbows. Provide a minimum of 1-inch clearance between the bottom of the base and floor on housekeeping pad with equipment in place, in operation and with spring isolators properly adjusted.

2.3 FLEXIBLE CONNECTIONS

A. Flexible connections for piping systems shall be as specified in Section 23 0504. Flexible connection for fan equipment and flexible ductwork shall be as specified in Section 23 3000.

2.4 SEISMIC SNUBBER TYPES

A. Reference: ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.) Handbook, 2007 HVAC Applications, Chapter 54 'Seismic and Wind Restraint Design'.

B. Type A: Coil Spring Isolator Incorporated within a Ductile Iron or Cast Aluminum Housing:

1. Cast iron or aluminum housing are brittle when subjected to shock loading and are therefore not approved for seismic restraint applications.

C. Type B: Coil Spring Isolator Incorporated within a Steel Housing:

1. Spring isolators shall be seismic control restrained spring isolators, incorporating a single or multiple coil spring element, having all of the characteristics of free standing coil spring isolators as specified in the vibration isolation portion of this specification. Springs shall be restrained using a housing engineered to limit both lateral and vertical movement of the supported equipment during an earthquake without degrading the vibration isolation capabilities of the spring during normal equipment operating conditions.
2. Vibration isolators shall incorporate a steel housing and neoprene snubbing grommet system designed to limit motion to no more than 1/4" in any direction and to prevent any direct metal-to-metal contact between the supported member and the fixed restraint housing. The restraining system shall be designed to withstand the seismic design forces in any lateral or vertical direction without yield or failure. Where the capacity of the anchorage hardware in concrete in inadequate for the required seismic loadings, an adapter baseplate to allow the addition of more or larger anchors will be fitted to fulfill these requirements. In addition to the primary isolation coil spring, the load path will include a minimum 1/4" thick neoprene pad.
3. Spring elements shall be color coded or otherwise easily identified. Springs shall have a lateral stiffness greater than 1.2 times the rated vertical stiffness and shall be designed to provide a minimum of 50% overload capacity. Non-welded spring elements shall be epoxy power coated and shall have a minimum of a 1,000 hour rating when tested in accordance with ASTM B-117.
4. To facilitate servicing, the isolator will be designed in such a way that the coil spring element can be removed without the requirement to lift or otherwise disturb the supported equipment.
5. Spring isolators shall be Model FHS or FMS Isolator/restraint as manufactured by Kinetics

Noise Control, or by other manufacturer's who can meet the requirements as specified herein.

D. Type C: Coil Spring Isolator Incorporated within a Steel Housing:

1. Spring isolators shall be seismic control restrained spring isolators, incorporating one or more coil spring elements, having all of the characteristics of free standing coil spring isolators per the vibration isolation section of this specification, for equipment which is subject to load variations and/or large external forces. Isolators shall consist of one or more laterally stable steel coil springs assembled into fabricated welded steel housings designed to limit movement of the supported equipment in all directions.
2. Housing assembly shall be made of fabricated steel members and shall consist of a top load plate complete with adjusting and leveling bolts, adjustable vertical restraints, isolation washers, and a bottom load plate with internal non-skid isolation pads and holes for anchoring the housing to the supporting structure. Housing shall be hot dipped galvanized for outdoor corrosion resistance. Housing shall be designed to provide a constant free and operating height within 1/8".
3. The isolator housing shall be designed to withstand the project design seismic forces in all directions.
4. Coil spring elements shall be selected to provide static deflections as shown on the vibration isolation schedule or as indicated or required in the project documents. Spring elements shall be color coded or otherwise easily identified. Springs shall have a lateral stiffness greater than 1.2 times the rated vertical stiffness and shall be designed to provide a minimum of 50% overload capacity. Non-welded spring elements shall be epoxy powder coated and shall have a minimum of 1,000 hour rating when tested in accordance with ASTM B-117.
5. Spring isolators shall be Model FLSS as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as specified herein.

E. Type D: Coil Spring Isolator Incorporated within a Steel Housing:

1. Spring isolators shall be lateral restrained spring isolators, incorporating a single coil spring element, having all of the characteristics of free standing coil spring isolators as previously specified. Springs shall be assembled into a welded steel housing engineered to limit lateral movement of supported equipment during an earthquake without degrading the vibration isolation capabilities of the spring during normal operating conditions.
2. Vibration isolators shall incorporate a steel angle and plate motion limiting assembly and steel coil spring, designed as a system to accept a force in any lateral direction in excess of the design seismic requirement for the isolator without yield or failure. Isolator shall limit lateral movement of the equipment to less than 1/4" in any direction. The lateral limit stop shall incorporate a neoprene grommet to prevent the potential for metal-to-metal contact. The vibration isolation element shall include a 1/4" thick ribbed neoprene noise stop pad, positioned outside of the housing anchorage path. The housing shall incorporate drilled holes for attachment to the supporting structure.
3. Spring isolators shall be Model FYS as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as specified herein.

F. Type E: All Direction Neoprene Isolator:

1. Vibration isolators shall be neoprene, molded from oil resistant compounds, designed to operate within the strain limits of the isolator so to provide the maximum isolation and longest life expectancy possible using neoprene compounds. Isolators shall include encapsulated

cast-in-place top steel load transfer plate for bolting to equipment and a steel baseplate with anchor holes for bolting to the supporting structure. Ductile iron or cast aluminum components are not acceptable alternatives and shall not be used due to brittleness when subjected to shock loading.

2. Isolator shall be capable of withstanding the design seismic loads in all directions with no metal-to-metal contact.
3. Isolator shall have minimum operating static deflections as shown on the project vibration isolation schedule or as otherwise indicated in the project documents and shall not exceed published load capacities.
4. Neoprene isolators shall be Model RQ as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as specified herein.

G. Type F: All Direction External Seismic Snubber Assembly:

1. Equipment shall be restrained against excessive movement during a seismic event by the use of 3-axis resilient snubbers, designed to withstand the project required seismic forces.
2. Snubbers shall be of welded steel construction and shall be attached to the equipment structure and equipment in a manner consistent with anticipated design loads. Snubbers shall limit lateral and vertical equipment movement at each snubber location to a maximum of 1/4" in any direction.
3. Snubbers shall include a minimum of 1/4" thick resilient neoprene pads to cushion any impact and to avoid any potential for metal-to-metal contact. Maximum neoprene bearing pressure shall not exceed 1500 pounds/Sq. Inch. Snubber shall be installed only after the isolated equipment is mounted, piped, and operating so as to ensure that no contact occurs during normal equipment operation.
4. Three-axis seismic snubbers shall be Model HS-5/7 as manufactured by Kinetics Noise Control, or by other manufacturer's who can meet the requirements as specified herein.

H. Type G: All Direction Lateral External Seismic Snubber Assembly:

1. Equipment shall be restrained against excessive lateral movement during a seismic event by the use of 2-axis horizontal resilient snubbers, designed to withstand the project required seismic forces.
2. Snubbers shall be of welded steel construction and shall be attached to the equipment structure and equipment in a manner consistent with anticipated design loads. Snubbers shall limit lateral equipment movement at each snubber location to a maximum of 1/4".
3. Snubbers shall include a minimum of 1/4" thick resilient neoprene pads to cushion any impact and to avoid any potential for metal-to-metal contact. Snubber shall be installed only after the isolated equipment is mounted, piped and operating so as to ensure that no contact occurs during normal equipment operation.
4. Two-axis lateral seismic snubbers shall be Model HS-2 as manufactured by Kinetics Noise Control, or by other manufacturer's who can meet the requirements as specified herein.

I. Type H: Two-Axis External Seismic Snubber Assembly:

1. Equipment shall be restrained against excessive vertical and horizontal movement during a seismic event by the use of 2-axis resilient snubbers, designed to withstand the project required seismic forces. A minimum of four (4) snubbers are to be used at each equipment installation, oriented to effectively restrain the isolated equipment in all three directions.
2. Snubbers shall be of welded steel construction and shall be attached to the equipment

structure and equipment in a manner consistent with anticipated design loads. Snubbers shall limit lateral and vertical equipment movement at each snubber location to a maximum of 1/4" in any direction.

3. Snubbers shall include resilient neoprene pads within a minimum thickness of 1/4" to cushion any impact and to avoid any potential for metal-to-metal contact. Snubber shall be installed only after the isolated equipment is mounted, piped, and operating so as to ensure that no contact occurs during normal equipment operation.
4. Two-axis seismic snubbers shall be Model HS-4 as manufactured by Kinetics Noise Control, or by other manufacturer's who can meet the requirements as specified herein.

J. Type I: Single-Axis External Seismic Snubber Assembly:

1. Equipment shall be restrained against excessive horizontal one-axis movement during a seismic event by the use of single-axis resilient snubbers, designed to withstand the project required seismic forces. A minimum of four (4) snubbers are to be used at each equipment installation, oriented to effectively restrain the isolated equipment in all lateral directions.
2. Snubbers shall be of welded steel construction and shall be attached to the equipment structure and equipment in a manner consistent with anticipated design loads. Snubbers shall limit lateral equipment movement at each snubber location in the direction of impact to a maximum of 1/4".
3. Snubbers shall include resilient neoprene pads within a minimum thickness of 1/4" to cushion any impact and to avoid any potential for metal-to-metal contact. Snubber shall be installed only after the isolated equipment is mounted, piped, and operating so as to ensure that no contact occurs during normal equipment operation.
4. Single-axis seismic snubbers shall be Model HS-1 as manufactured by Kinetics Noise Control, or by other manufacturer's who can meet the requirements as specified herein.

K. Type J: Cable Restraints for Suspended Piping and Ductwork:

1. Seismic wire rope cable restraints shall consist of steel wire strand cables, sized to resist seismic loads, arranged so to offer seismic restraint capabilities for piping, ductwork, and suspended equipment in all lateral directions.
2. End connection fittings shall be designed to swivel in order to ensure proper cable alignment and to avoid bending of rope. Protective thimbles shall be used at connection points so to eliminate bending cable across sharp edges.
3. Anchoring hardware at each end of the cable shall be designed so to exceed the working project design load of the wire cable by a minimum of 50 percent.
4. Seismic cable restraints shall be Model SCR as manufactured by Kinetics Noise Control, or by other manufacturer's who can meet the requirements as specified herein.

2.5 SEISMIC RESTRAINTS

A. Seismic restraints shall be furnished and installed as specified herein and as required. Installation of all seismic restraint materials specified herein shall be accomplished following the manufacturer's written instructions. Installation instructions shall be submitted to the Engineer for approval prior to the beginning of the work.

B. All mechanical equipment not mounted on spring isolators shall be provided with seismic restraints, as specified and detailed on the drawings, designed to restrain movement in vertical and horizontal

directions during a seismic condition.

C. All ductwork, piping systems, and suspended equipment including air terminal units shall be supported to resist seismic forces in accordance with SMACNA guidelines or by means of an approved bracing system equivalent to Kinetics, Pipe Shields Incorporated, or Mason. The seismic restraint manufacturer shall provide documentation on maximum restraint spacing for various cable sizes and anchors, as well as worst case reaction levels at restraint locations.

D. All seismic snubber restraint assemblies shall meet the following minimum requirements:

1. Impact surface should have a high quality elastomeric facing so to ensure that no metal-to-metal contact can occur.
2. Resilient material should be easy to visually inspect for damage and be replaceable if necessary.

    a. Resilient material used in snubber assemblies to be a minimum of 0.25" thick.
    b. Resilient material used in snubber grommets to be a minimum of 0.12" thick.

3. Assembly must be designed to offer seismic restraint in all directions, unless otherwise noted below.
4. Clearance between resilient material and contacting isolated equipment surface must not exceed 0.25".
5. Seismic restraints capacities to be verified by an independent test laboratory or certified by a registered State of New Mexico Structural Engineer who is experienced in seismic restraint design to ensure that the design intent of this specification is realized.

E. The Contractor shall ensure that all housekeeping pads used are adequately reinforced and are properly attached to the building structural flooring, so to withstand anticipated seismic forces. In addition, the size of the housekeeping pad is to be coordinated with the seismic restraint manufacturer so to ensure that adequate edge distances exist in order to obtain desired design anchor capabilities.

PART 3 - EXECUTION

3.1 GENERAL

A. All mechanical equipment scheduled on the drawings shall be isolated from building structure by means of resilient vibration and noise isolators supplied by a single manufacturer to the Contractor. The isolator manufacturer shall submit a tabulation of the design data on the isolators including spring O.D., free operating and solid heights of springs, free and operating heights of neoprene isolators. Static deflection scheduled is the minimum acceptable and represents the static deflection required based on the combined weight of the equipment; motor bases and any other accessories specified in the mechanical equipment schedule. Isolation bases shall be furnished by the Vibration Isolator Manufacturer. Vibration isolation system shall have a maximum lateral motion under equipment start-up and shutdown conditions of 1/4-inch. Restrain excess motion by spring type mountings. Connections to equipment shall allow for deflections equal to or greater than equipment deflections.

B. Seismic restraints shall be in accordance with the State of New Mexico requirements and the Uniform Building Code, and shall be designed to resist seismic forces of magnitudes as specified herein. Installation of seismic restraints shall follow SMACNA guidelines.

C. The Contractor shall coordinate the installation of the vibration isolation and seismic restraint devices with all trades and subcontractors. Contractor shall verify with the Architect that the devices and supports are adequate as intended and do not overload the building structural components in any way. The exact method and means of connection of the mechanical system to the building structural system shall be approved by the Architect.

D. Installation of all seismic restraint materials specified in this section shall be accomplished as per the manufacturer's written instructions.

E. Upon completion of installation of all seismic restraint materials and before start up of restrained equipment, all debris shall be cleaned from beneath all protected equipment, leaving equipment free to contact snubbers.

F. No rigid connections between the equipment and the building structure shall be made which degrades the seismic restraint system herein specified. All electrical conduit to restrained equipment shall be looped to allow free motion of equipment without damage to the electrical wiring.

3.2 EQUIPMENT CONNECTIONS

A. No rigid connections between equipment and building structure shall be made that degrades the noise and vibration isolation system herein specified.

B. Electrical circuit connections to isolated equipment shall be looped to allow free motion of isolated equipment; see Division 26.

C. Coordinate work with other trades to avoid rigid contact with the building. Inform other trades following work, such as plastering or electrical, to avoid any contact which would reduce the vibration isolation.

3.3 EQUIPMENT ISOLATORS

A. The minimum operating clearance between the equipment frame or the equipment vibration base frame and the housekeeping pad or floor shall be 1".

B. The equipment vibration base shall be placed in position and supported temporarily by blocks or shims, as appropriate, prior to the installation of the machine or isolators.

C. After the entire installation is complete and under full operational load, the isolator shall be adjusted so that the load is transferred from the blocks to the isolator. When all isolators are properly adjusted, the blocks or shims shall be free and shall be removed.

D. Isolator static deflection shall be (minimum) as specified or scheduled on the Drawings.

E. Position all corner or side seismic restraints with equipment operation for proper operating clearance

and weld or bolt seismic restraint to seismic anchor plates in housekeeping pad.

F. Install equipment with flexibility in piping and wiring connections.

G. Verify all installed isolators and mounting systems permit equipment motion in all directions. Adjust or provide additional resilient restraints to limit start-up equipment lateral motion to 1/4".

H. Prior to start-up, clean out all foreign matter between bases and equipment. Verify that there are no isolation short circuits in the base, isolators or seismic restraints.

3.4 SEISMIC RESTRAINT FOR PIPING

A. Seismically restrain all piping listed below. Use Type 'J' cable restraints for all piping supported by vibration isolation hanger assemblies, including:

1. Natural gas piping, medical gas piping, vacuum piping, petroleum based liquid piping, and compressed air piping equal to or greater than 1" in inside diameter.
2. All piping located within mechanical equipment and service rooms equal to or greater than 1-1/4" in inside diameter.
3. All other piping equal to or greater than 2-1/2" in inside diameter.

B. Type 'J' cable seismic restraint sizes, quantities, locations and mounting details per SMACNA (Sheet Metal and Air Conditioning Contractors National Association, Inc.) 'Seismic Restraint Manual Guidelines for Mechanical Systems,' Latest Edition.

3.5 SEISMIC RESTRAINT FOR DUCTWORK

A. Seismically restrain all ductwork listed below. Use Type 'J' cable restraints or equivalent for all ductwork, including.

1. All rectangular and oval ducts with cross sectional area equal to or greater than 6 square feet.
2. All round ducts with diameters equal to or greater than 28".
3. Type 'J' cable seismic restraint sizes, quantities, locations and mounting details per SMACNA (Sheet Metal and Air Conditioning Contractors National Association, Inc.) 'Seismic Restraint Manual Guidelines for Mechanical Systems', Latest Edition.

3.6 SEISMIC RESTRAINT FOR FIRE PROTECTION PIPING

A. Fire protection, sprinkler piping and related equipment is considered as 'Life Safety Equipment' and shall be seismically restrained per guidelines as published by NFPA (National Fire Protection Association) as specified in Division 21.

3.7 PIPING, DUCTWORK AND CONDUIT EXCLUSIONS

A. Per the IBC (International Building Code), piping and ductwork which have diameter or cross sectional areas less than those noted in Sections 3.4, 3.5, and 3.6 do not require additional seismic

restraint over and above the normal suspension hardware.

3.8 INSPECTION

A. The Contractor shall notify the local representative of the seismic restraint materials manufacturer's representative prior to installing any seismic restraint devices. The Contractor shall seek the representative's guidance in all installation procedures.

B. The local representative of the seismic restraint and snubber materials manufacturer shall conduct periodic inspections, minimum of monthly during construction period for equipment, piping and ductwork seismic restraint system installation. Inspection reports shall be in writing to the Contractor any deviations from good installation practice observed. These reports shall be forwarded to the Architect for review.

C. On completion of installation of all seismic restraint and vibration isolation devices herein specified, the vibration isolation manufacturer shall inspect the completed system and submit an inspection report to the Architect. This report shall identify any installation error, improperly selected isolation devices, or other problems that could affect the performance of the system. The manufacturer's report shall include recommendations for any actions required to properly complete the vibration isolation and seismic restraint work. The cost of the inspection shall be included in the contractor's bid price.

D. The installing Contractor shall submit a final report to the Project Architect and/or Engineer, including the manufacturer representative's final report, certifying that all seismic restraint material has been properly installed, or steps to be taken by the Contractor to properly complete the seismic restraint work per the specifications.

END OF SECTION 230548

SECTION 230549 - HVAC AND ELECTRICAL INSTALLATION COORDINATION

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

1.2 RELATED DIVISIONS AND SECTIONS

A. Section 23 0500, Common Work Requirements for HVAC.

B. Section 23 0900, Facility Management System.

C. Division 26 for Electrical.

D. Division 28 for Electronic Safety and Security.

1.3 SCOPE

A. It is the intention of this section to summarize the coordination of effort defined in the related sections and divisions of this specification.

B. If there is a conflict between this Section and other Sections and Divisions of this specification, this Section shall be the governing and decisive Section.

C. Make all connections to motors and controls for equipment supplied and/or installed under Division 23 according to Table 1 on the following page.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3.1 INSTALLATION

A. No work shall be performed until the reviewed and marked submittal data have been reissued to the Contractor, unless written permission is obtained from the Architect.

TABLE 1

Item or System	Note	Supplied By (3)	Installed By (3)	Powered By	Control Field Wiring By
Equipment Motors		Div. 23	Div. 23	Div. 26	N/A
Motor Control Center Including Starters, Pilot Lights, Heater, Switches, Auxiliary Contacts, and Internal Control Wiring		Div. 26	Div. 26	Div. 26	Div. 23
Stand Alone Motor Starters (outside motor control centers)	(1)	Div. 26	Div. 26	Div. 26	Div. 23
Variable Frequency Drives (VFD's)		Div. 23	Div. 23	Div. 26	Div. 23
Fused and Non-Fused Disconnects	(1)	Div. 26	Div. 26	Div. 26	N/A
Control Relays & Control Transformers	(1)	Div. 23	Div. 23	Div. 26	Div. 23
Kitchen Make-up System & Hood Exhaust Fans		Div. 23	Div. 23	Div. 26	Div. 26
Kitchen Exhaust Hoods		Div. 23	Div. 23	Div. 26	N/A
Kitchen Hood Fire Protection System		Div. 23	Div. 23	Div. 26	N/A
Kitchen Hood Natural Gas Shut-Off Valve		Div. 23	Div. 23	Div. 26	N/A
Fan Coil Units Including		Div. 23	Div. 23	Div. 26	Div. 23
Min. Outside Air Units Including Mixing Dampers		Div. 23	Div. 23	Div. 26	Div. 23
Rooftop A/C Units Including Mixing Dampers		Div. 23	Div. 23	Div. 26	Div. 23
HVAC Unit Smoke Detectors		Div. 28	Div. 23	Div. 28	Div. 28
Fire/Smoke Control Dampers & Smoke Dampers		Div. 23	Div. 23	Div. 26	Div. 28
Fan Coil Unit Condensate Float Switches		Div. 23	Div. 23	N/A	Div. 23
Supply, Return & Exhaust Fan with unit mounted 115 VAC 2-position damper actuators interlock with fan motor/starter		Div. 23	Div. 23	Div. 26	N/A
Non-FMS Control Devices Including Wall Switches, Timers, Thermostats		Div. 23	Div. 23	Div. 26	Div. 26
Facility Management System (FMS)	(2)	Div. 23	Div. 23	Div. 23	Div. 23
Fire Alarm System & Interface w/HVAC System		Div. 28	Div. 28	Div. 28	N/A

TABLE NOTES:

1. Unless specified to be supplied with the equipment
2. Division 26 shall provide 120 VAC power to each mechanical space and the central plant as indicated on the drawings. Any additional power, transformers, and distribution shall be provided by the Section or Division indicated.
3. Division 23 indicates the HVAC contractor or their designated representative including equipment suppliers, sub-contractors, etc.

END OF SECTION 230549

SECTION 230593 - TESTING, ADJUSTING AND BALANCING OF MECHANICAL SYSTEMS

PART 1 - GENERAL

1.1 GENERAL

A. Conform with applicable provisions of the General Provisions and the General Requirements.

B. Testing, adjusting and balancing (TAB) shall be performed by a TAB Agency which is independent of the Mechanical Contractor.

C. The TAB Agency's efforts shall be paid for by the Contractor and included in the mechanical contract price.

D. Unless specifically noted, all work specified in this section shall be included in the scope of the TAB Agency's work. But some work described in this section is to be performed by the mechanical contractor, controls contractor, or others, and that work is specifically noted to be by these entities.

1.2 SCOPE

A. Provide TAB for the systems and equipment installed under Division 23, including but not limited to:

1. Supply and exhaust air systems including process and kitchen systems.
2. Variable Refrigerant Flow System.
3. Return air where specifically noted.
4. Hydronic systems including domestic HW return systems.

B. Provide all labor, instruments, and tools necessary to test, adjust and balance the systems shown on the drawings and/or described in these specifications. Check equipment performance, take measurements, adjust systems and equipment to provide specified performance, and report results. Submit reports to keep all parties posted on the progress of the TAB work.

C. Where the TAB effort indicates deficiencies in system performance, TAB Contractor shall take the lead in a collaborative effort to trouble-shoot and resolve these deficiencies. Engage the assistance of others where necessary, starting with the Mechanical Contractor and Controls Subcontractor. Take additional measurements as required to identify the cause of the deficiencies, perform additional TAB as required to bring the system in compliance with the design intent. Engage the assistance of the Engineer and others where necessary. Indicate final setpoints and readings in a final TAB report.

D. Include three days of effort on site for tests and/or balancing as directed in writing by the Owner's Representative beyond that described herein, but prior to substantial completion.

E. Include two days on site for TAB efforts as directed in writing by the Owner's Representative after substantial completion.

1.3 STANDARDS AND DEFINITIONS

A. Perform all work in accordance with these specifications and the latest edition of the NEBB Standards.

B. Air Handling Unit: Where the term Air Handling Unit (AHU) is used in this spec section, it shall include any factory fabricated or field erected unit that includes a fan and other components which filter, heat, cool, humidify or dehumidify the air stream. But the term AHU, where used in this section, does not include fan powered terminal units, fan coil units, unit heaters, cabinet unit heaters, etc.

C. Air Handling System: A fan or AHU and ductwork.

D. Hydronic System: A system in which a liquid is used to convey heat.

E. Record or Report: Where used as a verb, these terms mean to include in the TAB report.

1.4 QUALIFICATIONS

A. TAB agencies shall meet the following qualifications:

1. Membership in the Associated Air Balance Council (AABC), National Environmental Balance Bureau (NEBB) or the Testing, Adjusting and Balancing Bureau (TABB).
2. An office located within a 250 mile radius of the project site.
3. A minimum of five (5) years experience in the TAB field.

B. The following TAB Agencies are prior approved:

NEW MEXICO

1. Energy Balance & Integration
2. Kirk Air Co.
3. Native Air
4. N-Demand Test and Balance LLC
5. Air Moving Equipment Company

1.5 SUBMITTALS

A. Mechanical Contractor shall submit the name of the proposed TAB agency prior to the TAB agency performing any services.

1. Submit a list of proposed personnel, including resumes with related project experience and certifications.
2. Submit proposed TAB procedures, instrumentation and measurement equipment including calibration data, and proposed sample TAB report forms.

B. Pre-Construction Report: Prior to the Mechanical Contractor installing the systems, the TAB Agency shall submit a letter indicating whether the design includes all devices the TAB Agency will need to successfully perform the TAB work. If any additional balancing devices are needed, the TABB Agency shall so note this in the pre-construction report.

C. Submit TAB reports as noted herein. Reports shall be in both hard copy and PDF format.

1.6 TAB PREPARATION AND COORDINATION

A. Mechanical Contractor shall perform the following in a timely fashion:

1. Provide the TAB Agency with the project documentation (drawings, specifications, bulletins, submittals, shop drawings, etc.) necessary to perform the TAB services.
2. Install, fill, pressure test, start up, clean, and the vent systems to be tested and balanced.

B. Controls Subcontractor shall perform the following in a timely fashion:

1. Install and make operational all necessary control systems and equipment, including computers and computer programs.
2. Provide qualified personnel to operate the systems as necessary to support the TAB effort. Provide the TAB contractor with the computer software necessary to facilitate the TAB effort.
3. Assist as required to resolve problems which become evident due to TAB work, and as required to obtain specified system performance.

PART 2 - PRODUCTS

2.1 EQUIPMENT

A. Provide all equipment and instruments necessary to perform the work specified herein. Calibrate and maintain instruments per NEBB Standards. Provide not less than the following:

1. Pitot tubes and draft gauges.
2. Flow hood.
3. Velometer.
4. Thermometers.
5. Pressure gauges.
6. Flow meter test kit.
7. Ampere – voltmeter.
8. Speed indicator.
9. Sound meter to measure eight octave bands.

PART 3 - EXECUTION

3.1 GENERAL

A. Review and inspect the mechanical systems for conformance with design documents. Test, adjust and balance all system flows under design conditions and under other conditions where part load testing is specified. Comply with measurement tolerances per NEBB. Balance to within 10% of design flows unless otherwise specified.

B. Visually mark the final settings of balancing dampers, balancing valves, fan speed controls, etc.

C. Comply with NEBB Standards. The descriptions included herein are a guide to the minimum information needed.

D. Troubleshooting: In the event that any areas fail to get proper flow, take the lead in troubleshooting the system. Measure pressures, flows, etc. at various points throughout the systems as required to identify the cause of the deficiencies and identify upgrades which will resolve these deficiencies. Coordinate any remedial efforts directly with mechanical and controls contractors and re-test as required.

3.2 TEST AND BALANCE REPORT

A. Report shall be 8-1/2" x 11" bound into a complete and coherent report, except that drawings may be larger size, but still bound into the report. All forms shall be typewritten or legibly handwritten.

B. Include the following sections in the order indicated:

1. Cover sheet with the Project Name, Location, and the names of the Mechanical Contractor and Engineer
2. Table of Contents
3. Summary indicating the highlights of the report and summarizing any deficiencies and recommendations
4. Test results including the names of the persons performing the tests and dates the tests were performed
5. Drawings
6. Description of the test procedures used
7. List of instruments used along with their calibration data
8. Qualifications of personnel

C. Submit five copies and a PDF of the complete TAB report minimum two weeks before the first O&M instruction session. One copy will be returned to the Contractor with review comments.

3.3 BASIC AIR HANDLING SYSTEM TESTING, ADJUSTING AND BALANCING

A. General

1. Test all fans and air handling systems. Balance systems to achieve specified air flows while minimizing throttling losses.
2. Air Flow Measurements: Fan and AHU flow rates may be determined by pitot tube traverse or by measuring fan speed, suction and discharge pressures, and comparison with the fan curve. Measure duct air flows using pitot tube traverses. Measure air flows of grilles, registers and diffusers using either capture hoods or pitot tube traverses in the connected ductwork. Make such other tests as may be required to demonstrate that systems perform per the design requirements.
3. Air Flow Measuring Stations: Calibrate each air flow measuring station which is provided as part of the construction contract. Use duct pitot tube traverses or other appropriate means to measure air flows. Coordinate with the flow measuring station supplier, and enter calibration coefficients into the FMS. Record the results of this effort.
4. Alert Mechanical Contractor and Engineer if any fan or air handling unit (AHU) appears to be operating in an improper or unsafe condition.
5. Seal all test holes in ductwork once testing is complete. Repair insulation jackets to maintain the integrity of the vapor barrier.
6. Include in the report copies of ductwork drawings with test points indicated.
7. Variable Flow Systems: Verify proper fan tracking from full flow to 50% flow.

B. Fans: Perform the following for all fans, including those provided as part of an AHU.

1. Fan Nameplate: Record unit number per the equipment schedule, manufacturer, model, size, and serial number.
2. Performance Data: Measure air flow and adjust fan speed to achieve required flow. Record air flow, static pressure rise and fan speed.

    a. Advise when belt and/or sheave changes are required to achieve the design flows. Mechanical contractor shall make the necessary changes as part of the mechanical contract. Approximately 25% of fans may require a sheave and/or belt change.

3. Current and Voltage: Record motor nameplate and measured voltage and amperage. Advise if motor amps exceed rated load amps.

C. Air Handling Units:

1. Outside Air: Test outside air flows using a pitot tube traverse and balance as required. If a traverse is not practical, use the mixed air temperature method if the inside and outside temperature difference is at least 20 deg F, or use the difference between pitot tube traverses of the supply and return air ducts.
2. Static Pressure: Measure and record the static pressure at the inlet and outlet of each AHU component, including louvers, dampers, filters, coils, etc, and at each inlet and discharge duct connection.

D. Coils: Measure and record air and water flows and pressure drops.

E. Air Distribution Systems:

1. Zone, Branch and Main Ducts:

a. Adjust to within 10% of design air flows. Balance so that at least one zone balancing damper is wide open. Balance multi-diffuser branch ducts so that at least one outlet or inlet damper is wide open.

2. Air Terminal Units:

a. Calibrate flow sensors and enter design maximum and minimum flow setpoints into FMS.
b. Record terminal unit number, size, specified flow, agency measured flow, FMS measured flow, and DDC flow correction factors.

3. Diffusers, Registers and Grilles:

a. Test, adjust, and balance each diffuser, grille, and register to within 10% of specified design requirements. Record the size of each grille, diffuser, and register, initial flow measurement, and final measured flow.
b. Where rooms are indicated to be maintained at either positive or negative pressure, balance air flows to achieve these conditions under design flow conditions, and verify proper pressurization at minimum flow.

F. Fan Coil Units, Unit Heaters, Cabinet Unit Heaters, Air Curtains, Door Fans, Fan Powered Terminal Units and other devices with fans and coils:

1. For each unit, record unit number, manufacturer, model, size, motor HP, voltage and rated load amps and design air flow.
2. Measure and record initial air flows, along with final air flows, unit inlet and outlet static pressures, voltages, and motor amps.
3. Measure and record initial and final water flows and pressure drops.

G. Energy Recovery Units:

1. For each unit, record unit number, manufacturer, model, size, motor HP, voltage and rated load amps and design air flow.
2. Measure and record initial air flows, along with final air flows, unit inlet and outlet static pressures, voltages, and motor amps.

H. Duct Leakage Testing

1. Specification Section 23 3000 describes the requirements for duct leakage testing. Provide all instrumentation and labor to take the required measurements.
2. The Mechanical Contractor shall provide the fans and all other required work.
3. Submit test report. Retest until ductwork complies with specified leakage criteria.

3.4 HYDRONIC SYSTEMS

A. General:

1. Prior to commencing hydronic balance:

a. Set valves to proper position per the sequence of operation.

b. Check pump rotation.
c. Verify that system is adequately pressurized.
d. Set temperature controls so all system components deliver maximum flow.
e. Balancing may be done in sections.

2. Pumping Systems: Measure flows and determine operating characteristics of hydronic systems (where applicable). Make measurements at maximum flow.
3. Balance systems to minimize throttling out in the distribution, and to instead throttle at the pump discharge. Recommend impeller trimming if appropriate.

4. Domestic HW return system: Balance to ensure HW availability throughout the system. Where balancing valves are provided, record flow and balance to provide flow in each circuit.

3.5 LIMIT DEVICES AND SAFETY CONTROLS

A. Limit Devices: Check all limit devices to verify proper operation, including, freezestats, flow switches, etc. Include in the TAB report a list of all such devices and the results of their tests.

B. Fire and Smoke Dampers

1. Test each fire damper, smoke damper, and fire/smoke damper to ensure proper operation. Record test results.
2. Fire Dampers: Open access door, disconnect fusible link or activate thermal link, and verify that damper closes smoothly and completely. Reset damper and access door.
3. Smoke Dampers: Open access door, activate damper, observe whether it closes smoothly and completely, and measure closing time. Reset damper and verify it opens completely. Close access door and record test results.

C. Life Safety Controls: Test and record life safety control operation of the HVAC systems. Verify the installation of required smoke detectors in air handling equipment, and verify operation of the smoke detector by activating the smoke detector and observing air handler shutdown or other required functions as described on the control drawings and sequence of operation. With assistance from the contractors for mechanical, temperature controls and electrical work, verify the operation of interconnected systems, such as the smoke detector's activation of the fire alarm system and the alarm system's activation of the life safety control sequence.

3.6 SOUND TESTING

A. Measure sound level in approximately ten percent of rooms as directed by Engineer.

1. Shut off mechanical equipment and measure background sound level in each octave band.
2. Start mechanical equipment and measure sound level in each octave band.
3. Submit a plot of measured data against noise criteria (NC) curves.

B. Where measured sound levels are deemed by Owner to be unacceptable, work with Engineer and Mechanical Contractor to reduce actual levels, and retest as required.

3.7 AIR HANDLING SYSTEMS – SPECIAL APPLICATIONS

A. Kitchen Hood Exhaust Systems

1. Air Flows: Test the exhaust air flow of each kitchen hood, and at each hood outlet connection. Use duct pitot tube traverses. Adjust fan speed as required to achieve design air flows. Adjust makeup air systems as required.
2. Capture Characteristics: For each Type 1 hood, set a smoke emitting device in several locations (minimum one location per four foot hood length, but not less than two locations per hood) and observe capture characteristics. Adjust makeup air system to optimize capture characteristics. Record test results.
3. Sealing test holes: After testing the Mechanical Contractor shall properly seal all test holes in the exhaust duct.

END OF SECTION 230593

SECTION 230700 - MECHANICAL SYSTEMS INSULATION

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

1.2 RELATED SECTIONS

A. Section 23 0500, Common Work Requirements for HVAC.

B. Section 23 0504, Pipe and Pipe Fittings.

C. Section 23 3000, Air Tempering System and Equipment.

1.3 SCOPE

A. Field insulation of piping: see drawings and Part 3 of this specification.

B. Field insulation of ductwork: See drawings, Table 23 0700-1, and Part 3 of this specification.

C. Field insulation of equipment supplied and/or installed under Division 23: See drawings and Part 3 of this specification.

D. Factory-insulated equipment and materials are described on the equipment schedule, on the drawings, and in other sections of this specification.

1.4 SUBMITTALS

A. Submit products to be used including insulation, jackets, miscellaneous products, and products for special applications. Review each application and advise if any product is either not suitable for, or not recommended for the application.

B. Verify that each submitted product meets all requirements for that product as specified herein. Include literature that clearly shows products meet all aspects of the spec. Include a cover sheet or letter with the following statement:

> "Each product submitted here meets all specified requirements for that product except as follows:" followed by a list of any discrepancies.

C. Submit schedules showing the type of product and thickness for each application. Indicate products to be used on valves and fittings. Indicate where vapor barriers will be provided and what jackets will be used.

D. D-5, D-6 & D-7 insulation: If one of these insulations is specified, submit documentation indicating that the submitted materials are approved for the intended service.

E. Submit a description of the application techniques to be used.

1.5 QUALITY ASSURANCE

A. Comply with the latest edition of the National Commercial & Industrial Insulation Standards, as published by the Midwest Insulation Contractors Association.

B. Part 3 and Table 23 0700-1 give the system temperatures for various applications. Supplier shall review these temperatures and confirm the suitability of all components for the specified applications.

C. Test piping and ductwork in accordance with applicable specification sections before insulation is applied.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials must be 100% asbestos-free and 100% formaldehyde-free, NO EXCEPTION.

B. All materials must be GreenGuard Gold Certified.

C. Smoke and Fire Ratings: All materials shall have a composite fire and smoke hazard rating not exceeding flame spread 25, fuel contribution 50, smoke developed 50, when tested as assemblies per ASTM Standard E-84 or NFPA 255.

D. Thermal conductivities: Per ASTM C518. Do not exceed the conductivities indicated. Units listed herein for conductivity are Btuh-in/SF-F. Resistance shall not be less than the values specified herein. Units for resistance are SF-F/Btuh.

E. Noise Reduction Coefficients: Per ASTM C423 based on Type A mounting. NRC shall not be less than as specified.

F. Jackets: Maximum 0.02 perm water vapor transmission per ASTM E96 Procedure A.

1. ASJ: All service jacket per ASTM C1136 Type I, paintable white kraft paper outer surface reinforced with glass fiber yarn and bonded to aluminum foil, with self-sealing longitudinal lap and butt strips, breach puncture min. 50 oz-in/in tear per ASTM D781, tensile strength min. 30 lb/in per ASTM D828.
2. FSK: Foil skim kraft per ASTM C1136 Type II.

G. Fiberglass insulation: Inorganic fibers bonded with thermosetting resin.

H. Approved Manufacturers: Owens Corning, Johns Manville, Knauf, Certain-Teed, Kflex, Armacell, Unifrax -Insulfrax, Industrial Insulation Group, Pittsburgh Corning. Where the term

OAE is used herein, this refers to these manufacturers only. No other manufacturers are approved for this project.

2.2 PIPE INSULATION

A. General

1. Valves, Fittings, and Accessories: Use the same insulation materials and thickness as the pipe insulation, except as noted.

B. Type P-1, Fiberglass Pipe Insulation: Factory assembled insulation and ASJ. Pre-formed fiberglass per ASTM C547 Type I, suitable for use on surfaces from 0–850ºF, with thermal conductivity 0.23 at 75ºF or 0.33 at 250ºF, and minimum 3 pcf density. ASJ shall have self-sealing lap at end and along length, with pressure sensitive tape lap sealing system. Owens Corning SSL II Pipe Insulation, Johns Manville Micro-Lok, Knauf Pipe Insulation.

1. Where Type P-1 insulation is used, insulate fittings, valves and accessories using one of the following:

a. Fiberglass pre-formed fitting insulation complying with the specification for P-1 pipe insulation, Johns Manville Hi-Lo Temp insulation inserts, Hamfab, OAE. Finish with Type J-2 fitting covers.
b. Where pre-formed fitting insulation is not available, the following may be used: minimum 0.75 pcf density fiberglass per spec for D-1 insulation except without FSK. Finish with Type J-2 fitting covers or with two coats of fitting mastic with fiberglass fitting tape embedded between coats.

C. Type P-2, Fiberglass Pipe and Tank Insulation: Similar to Type P-1 insulation and jacket, except with fibers oriented to allow insulation to be wrapped onto curved surfaces, with conductivity 0.30 at 100ºF, or 0.55 at 400ºF. Johns Manville Pipe & Tank Insulation, Owens Corning Pipe and Tank Insulation or Knauf Pipe and Tank Insulation.

1. Alternate: Fiberglass board insulation similar to Type D2, scored for application on curved surfaces, with ASJ.

D. Type P-3, Calcium Silicate Pipe Insulation: Rigid calcium silicate per ASTM C533, Type 1, asbestos-free, suitable for use on piping up to 1200ºF, conductivity 0.55 at 700ºF, compressive strength min. 200 psi at 5% compression. Industrial Insulation Group OAE.

1. Fittings, valves and accessories: Insulate with mitered Type P-3 insulation or Type D-7 insulation.

E. Type P-4, Elastomeric Foam Pipe Insulation: Pre-formed elastomeric foam, ASTM C534 Type 1 flexible, closed cell, suitable for use up to 220ºF, UV protected, not to exceed flame spread 25 and smoke developed 50 based on 0.75-inch thickness, conductivity 0.30 at 75ºF. Kflex, Armacell OAE.

1. Fittings, valves and accessories: Insulate using either Type P-4 insulation pre-formed for use on fittings and valves, or cut sections of P-4 pipe insulation to match the shape of the fitting or valve, taped on using PVC tape.

2.3 DUCTWORK INSULATION

A. Type D-1, Fiberglass Blanket: Factory fabricated insulation and FSK jacket assembly suitable for applications from 40-250ºF, 3/4 pcf fiberglass, ASTM C553 Type I or II, with thermal resistance not less than the following for 2-inch thickness: 6.8 out of the box, 5.6 installed with 25% compression. Johns Manville Microlite XG Duct Wrap, Owens Corning Soft R Duct Wrap, Knauf Friendly Feel Duct Wrap, Certainteed Soft Touch Duct Wrap.

B. Type D-2, Fiberglass Board: Similar to Type D-1 except rigid board type, 3 pcf density, thermal conductivity 0.23 at 75ºF, NRC 1.36, suitable for unfaced side at up to 450ºF and faced side at up to 150ºF. Johns Manville 800 Series Spin Glas, Owens Corning 700 Series Board, Knauf Insulation Board, Certainteed Certra Pro Commercial Board

C. Type D-3, Acoustic Lining (roll type): Organic fiber or fiberglass duct liner bonded with thermosetting resin, with factory-applied acrylic surface coating treated with anti-microbial agent, and factory-applied or shop-applied edge coating.

1. Properties: Minimum 1.5 pcf density, thermal conductivity 0.24, 6000 FPM rated per UL 181, NRC 0.70 at 1-inch thick and .95 at 2-inch thick. The product (fiberglass, resin, coating, microbial agent and adhesive) as an assembly shall be suitable for surfaces and gases up to 250ºF, and shall comply with ASTM C1071 (Type I), G21 and G22.
2. Lining surface shall be cleanable using commercially available duct cleaning equipment when performed by qualified technicians using procedures established and recommended by the North American Insulation Manufacturer's Association (NAIMA) Duct Cleaning Guide.
3. Johns Manville Linacoustic RC, Owens Corning Acoustic R duct liner, Knauf EM duct liner, Certainteed ToughGuard R Duct Liner.

D. Type D-4, Acoustic Lining (board type): Similar to Type D-3 and complying with all aspects of the spec for Type D-3 insulation, except 3 pcf density rigid board with NRC 0.75 at 1-inch thick and 1.0 at 2-inch thick. Johns Manville Permacote Linacoustic R-300. Owens Corning Duct Liner Board, Knauf Rigid Plenum Liner, Certainteed Rigid Liner Board.

E. Type D-5, Grease Duct Applications: High temperature, foil-encapsulated inorganic blanket, 8 pcf. Insulfrax Fyre Wrap Max 2.0, Johns Manville Fire Temp, OAE. Product shall meet the following when applied as 2-layers around a grease-duct:

1. Tested and listed for zero clearance to combustibles across the entire surface of the blanket material per internal fire test AC101 or ASTM E2336 - Internal Fire Test – 2 Hr Grease Duct Enclosures.
2. Rated as a 2-hr fire resistive enclosure assembly per ASTM E-119, Engulfment Fire Test for 2-hr Grease Duct Enclosure.

F. Type D-6 –Combustible Materials within Plenum: For use on combustible materials located within supply or return air plenums, foil-encapsulated 8 pcf high-temperature ceramic fiber blanket suitable for service up to 1800ºF. Unifrax Fyre-Wrap 0.5 plenum insulation.

G. Type D-7 – Fire Rated Ductwork: Suitable for continuous operation at 1800ºF, 6-pcf, foil-encapsulated inorganic blanket to provide a 2-hour rating per ISO 6944 when applied in a single

1.5-inch thick layer. Insulfrax FyreWrap 1.5 OAE.

H. Type D-8 – Polystyrene Insulation: Rigid cellular square edge insulation per ASTM C578, waterproof, thermal conductivity 0.20, compressive strength 25 psi. Dow Styrofoam or Owens Corning Foamular.

I. Type D-9 – Fiberglass Ductboard: Listed per UL 181 as a Class 1 Rigid Air Duct; conforming to ASHRAE Std. 62, NFPA-90A and 90B, ASTM G-21 & G-22; rated for 2-in. wg; constructed of fiberglass bonded with a thermosetting resin, with double density slip joints pre-molded in the board; FSK jacket; thermosetting acrylic polymer interior surface, and black interior surface color. Thermal conductivity 0.23, and NRC 0.70 at 1-inch thick and 1.0 at 2-inch thick. Johns Manville Superduct 475 or 800, Owens Corning Quiet R Duct Board, Knauf Duct Board M, Certainteed ToughGard Duct Board

2.4 EQUIPMENT INSULATION

A. E-1, Removable Insulating Blanket: Factory fabricated, one-piece, removable and re-usable insulating blanket with fiberglass insulation completely enclosed within a silicone coated fiberglass cloth with draw cords of SS or PTFE coated glass fiber, and stainless steel clips. Insulation thickness shall be as specified elsewhere, but not less than 1-inch. Energy Systems Inc. “Q-Master” OAE.

2.5 INSULATION JACKETS

A. Type J-1, Metal Jacket: 0.010-inch smooth Type 304 stainless steel or 0.016-inch smooth or embossed aluminum per ASTM B-209, with minimum 1-mil polyethylene film with protective layer of 40 Lb virgin kraft paper, continuously laminated to full width inside jacket. Childers OAE.

1. Where jacket diameter is 16–96 in: 0.016-in. SS or 0.020 in. aluminum.
2. Equipment heads and all surfaces where jacket is greater than 96-inch OD: 0.020-inch SS or 0.024 inch aluminum.
3. Fittings and Accessories: Provide the same jacket material as for pipe.

B. Type J-2, PVC Jacket: Minimum 20 mil sheets and 30-mil pre-molded fitting covers, ASTM D1784, Class 16354-C. Accessories include solvent weld solution, stainless steel tacks, and tape. All components shall be white, UV resistant, with paintable exterior surface, and suitable for use at –20 to +150ºF. Johns Manville System 2000 (sheets), Zeston 300 (fitting covers), and Perma-Weld (solvent cement), OAE.

C. Type J-3, Canvas Jacket: 10 x 10 fiberglass mesh.

2.6 MISCELLANEOUS PRODUCTS

A. General:

1. Tapes: Aluminum, pressure sensitive, UL 181A-P listed and embossed, minimum 2.5-inch wide, Nashua 324A OAE.

2. Duct Liner Adhesives: Water-based, complying with ASTM C916.
3. Solvent Cement for PVC Jackets: Johns Manville Perma-Weld OAE.
4. Staples: Outward clinching, 0.5-inch galvanized steel

B. Piping Systems:

1. Pipe Hanger Insulation Inserts: Mechanical Pipe Shields Inc. “Snapp Itz” OAE.

C. Ductwork Systems:

1. Duct Liner Edge Sealer, Surface Sealer, Coatings & Adhesives: To meet ASTM C916. Johns Manville Superseal OAE.

2.7 SPECIAL APPLICATIONS

A. Handicap Lavatory Insulation Kit: Handi-Lav-Guard insulation kit per ANSI A117.1 with flexible vinyl finish.

PART 3 - EXECUTION

3.1 GENERAL

A. Delivery, Storage and Handling: Deliver and store insulation materials in factory-supplied containers. Protect from moisture. Do not install any materials that have gotten wet, regardless whether they are subsequently dried.

B. Store and apply materials in accordance with manufacturers’ recommendations, but not less than the following minimum temperatures. Ensure surfaces are clean and dry prior to application, and for minimum two hours after application:

1. Sealers, coatings, solvents and adhesives: 40^{o}F.
2. Tapes 50^{o}F.

C. Install in accordance with manufacturer’s recommendations, NAIMA recommendations, and this spec. Provide good ventilation.

D. Where vapor barriers are specified, ensure that the entire system is vapor sealed.

E. Protect materials from water damage. Replace any materials that are water-damaged prior to substantial completion.

3.2 PIPING INSULATION

A. General: Insulate piping as indicated herein and/or on the drawings. Except as noted, insulate all valves, fittings, and accessories with the same material and thickness specified for the pipe. Where piping is specified with a separate insulation jacket provide this same jacket for valves, fittings and accessories. Vapor seal cold piping systems.

1. Where insulation terminates, provide insulating cement beveled for a neat finish. For vaporsealed piping, coat with insulating mastic prior to applying insulating cement.
2. Strainers and Suction Diffusers: Either Type P-1 or P-3 insulation. Make provisions to easily remove and re-install insulation.
3. Pipe Supports: Provide high density calcium silicate insulation or insulation inserts as specified. Maintain pipe jacket and vapor barrier at supports. If necessary, apply a heavy coating of vapor barrier mastic material to prevent condensation from forming on supports. Provide galvanized steel insulation shields to protect insulation and jackets at supports.
4. Penetrations Through Building Construction: Insulation shall be continuous where piping passes through walls, floors, and other construction. Where insulated piping passes through fire and/or smoke rated construction, provide a section of UL approved fire safing insulation to match the required insulation thickness, or provide an insulated pipe sleeve as manufactured by Pipe Shield, Inc., OAE.
5. Mechanical Couplings: Where mechanical couplings are permitted, insulate them as specified for fittings.
6. All voids formed by support saddles or other mounting or support hardware shall be filled with insulation.

B. Application:

Temp Range	Temp (F)	Insulation Type	Vapor Sealed	Pipe Size				
				Under 1	1 - 1.5	Over 2 - 3	4 & 6	8 & Larger
TR-1	60&Less	P-1 or P-4	Yes	1.5	1.5	1.5	1.5	1.5
TR-2	61 – 104	P-1	Yes	0.5	0.5	0.5	0.5	0.5
TR-3	105 - 140	P-1	No	1.0	1.0	1.0	1.0	1.0
TR-4	141 - 200	P-1	No	1.5	1.5	2.0	2.0	2.0
TR-5	201 - 250	P-1	No	1.5	1.5	3.0	3.0	3.0
TR-6	251 - 350	P-1	No	1.5	2.5	3.0	3.0	3.0
TR-7	Over 350	P-1	No	2.5	3.0	3.0	4.0	4.0

1. Temperature Range TR-1: Refrigerant suction
2. Temperature Range TR-2: Domestic cold water, soft water, industrial water, process water of any type, non-potable water, interior horizontal roof drain and overflow bowls and piping, condensate drains indoors.
3. Temperature Range TR-3: Domestic hot water (including non-circulating HW within interior walls and chases) and domestic HW return except as noted.
4. Temperature Range TR-4: Refrigerant Liquid.
5. Temperature Range TR-5: Not Used
6. Temperature Range TR-6: Not Used
7. Temperature Range TR-7: Not Used

C. Special Applications

1. Handicap Lavatories: Insulate domestic hot and cold water piping and P-traps exposed below handicapped lavatories with insulation kit specifically designed for the application.
2. Plastic pipe in return air plenums: Provide 0.5-inch type D6 insulation.

D. Type P-1 & P-2, Fiberglass Insulation: Install in accordance with manufacturer's recommendations.

E. Type P-3, Calcium Silicate Insulation: Adhere to pipe or equipment using stainless steel wire. Provide removable J-1 jacket.

F. Type P-4, Elastomeric Foam: Seal all butt ends and longitudinal joints with Halstead Adhesive. When exposed to the weather, protect flexible tubing insulation with two coats of exterior weatherproof coating as recommended by manufacturer.

G. Jacketing: In addition to the finish and jacket specified for the particular type of insulation, provide the following:

1.	Indoor piping exposed to physical damage	Type J-2, PVC
2.	Mechanical Eqpt Spaces: Exposed piping less than 8 ft above floor or operator platform	Type J-2, PVC
3.	Exterior piping	Type J-1, Metal

3.3 DUCTWORK INSULATION

A. General:

1. Insulate all ducts except those specified to be uninsulated. The following ductwork need not be field insulated:

   a. Factory insulated ductwork and plenums.
   b. Ducts with acoustic lining, provided the lining thickness matches or exceeds the required insulation thickness.
   c. Exhaust ducts, except where noted.

2. See Table 23 0700-1 for additional information.
3. Ensure that ductwork is leakage tested prior to applying insulation. Inspect ductwork and repair any deficiencies prior to applying insulation. Do not apply insulation over deficient ductwork or plenum construction.
4. Ensure that ductwork is clean and dry before applying insulation.
5. For ductwork with acoustic lining the drawings indicate the "clear inside duct dimension" required. Over-size ducts as required to provide the required air flow area.

B. Type D-1, Fiberglass Blanket Insulation: Measure and cut insulation. Install so insulation is not excessively compressed at corners. For rectangular and flat oval ducts 24-inches and wider, provide stick pins and speed clip washers 18-inches on centers on the bottom, and clip off excess length of stick. Firmly butt insulation ends and longitudinal joints. Overlap jacket minimum 2-inches at end joints and longitudinal joints, staple on 6-inch centers, and continuously seal jacket. Provide vapor barrier mastic where ducts are indicated to be vaporsealed. Should gaps or fishmouths occur, re-staple and seal them with mastic. Use FSK tape and vapor barrier mastic to seal all penetrations of the FSK jacket, such as pins, tears, and hangers. Neatly trim and seal insulation at access doors, ends, damper rod controls etc. Verify proper damper operation.

C. Type D-2, Fiberglass Board Insulation: Attach with mechanical fasteners 12" on centers.

D. Type D-3 & D4, Acoustic Lining: Ductwork dimensions indicated on the drawings are net air flow dimensions inside liner. Increase duct size to accommodate liner. Completely line the inside surfaces of ducts and plenums specified and indicted. Comply with the NAIMA Fibrous Glass Duct Liner Standard (FGDLS), manufacturer's recommendations, and this spec. Adhere liner with minimum 90% coverage of adhesive, and secure with mechanical fasteners and washers per FGDLS and manufacturer's recommendations. Fastener length shall be sufficient to limit compression of liner to 1/8" maximum. Coat all cut edges and surface penetrations with edge sealer. Provide metal nosing for liner leading edges at fan discharge and for all ducts with air velocities exceeding 3,000 FPM. Maintain minimum 18-inch clearance from electric resistance heaters. Interrupt liner at dampers and apply external insulation at these locations.

1. Provide Type D-3 insulation for the 10 feet upstream of roof exhaust fans except in wet air streams.

E. Type D-5: Install insulation in a 2-layer system per manufacturer's instructions, including the use of mechanical fasteners for the underside of ducts, butting or overlapping of joints, and offsetting of joints on outer layer.

F. Type D-6: Install in accordance with manufacturer's instructions. Overlap seams and joints minimum 2-inches, affix with SS wire minimum 18-inches on centers, but not less than per manufacturer's recommendations, and tape seams and joints with aluminum tape.

G. Type D-7: Install insulation in a single-layer system per manufacturer's instructions. Mechanical fasteners for the underside of ducts shall be adhered to the duct in a manner suitable for the operating temperatures (welded or other suitable method). Butt or overlap joints per manufacturer's recommendations.

H. Type D-8: Wire in place with SS wire minimum 12-inches on centers, and provide J-1 jacket.

I. Type D-9: Install per manufacturer's recommendations, NAIMA standards, and SMACNA Fibrous Glass Duct Construction Standards. Provide ship lap seams and joints.

3.4 EQUIPMENT INSULATION

A. General: Where specified elsewhere, equipment will be factory insulated. Insulate all equipment as noted herein except portions of equipment that are factory insulated.

1. Fiberglass Board Insulation: Score, bevel, or miter to provide tight joints and secure in place with mechanical pin and clip fasteners and insulation bonding adhesive applied to underside surfaces, or with bands. Fill joints with insulation material and provide corner beads to protect edges of insulation.
2. Cold Tanks and Equipment: J3 jacket with two coats of approved vapor barrier mastic.
3. Factory Packaged Equipment: Field insulate the equipment and piping on factory-fabricated assemblies as if they were field installed, unless such items are factory insulated.

B. Storage Tanks: 2-inch type P2.

3.5 JACKETING

A. Type J-1, Metal Jacketing:

1. Ducts: Slope jacketing to shed rain.
2. Pipes: Install with seams at the 3 o'clock or 9 o'clock position to shed water. Band 12" on centers.
3. Joints and Seams: Overlap joints minimum 2-inches. Caulk with a weatherproof caulk when located outdoors.

B. Type J-2, PVC Jacketing: Secure in place with tacks and solvent welded joints. White PVC tape may be used indoors.

C. Type J-3, Canvas Jacket: Apply mastic at a rate of 60 to 70 sq. ft. per gallon, embed fiberglass mesh, smooth all wrinkles and apply finish coat of Sealfas, or equivalent.

END OF SECTION 230700

TABLE 23 0700-1 – DUCTWORK INSULATION

Service	Location	Condition	Insulation Type	Insulation Thickness (in)	Notes
Supply Air, Makeup Air, Outside Air	Indoor	Concealed	D1	1.5	1, 6
Supply Air, Makeup Air, Outside Air	Indoor	Exposed	D2	1.5	
Supply Air, Makeup Air, Return Air	Outdoor	All	D8	2	2, 4, 7
Supply Rectangular Ductwork downstream of Terminal Units, Fan Coil Units, Heat Pumps, Blower Coils and Low Velocity AHU's	Indoor	All	D1	1.5	1, 3
Return Rectangular Ductwork upstream of Fan Coil Units, Heat Pumps, Blower Coils and Low Velocity AHU's	All	All	D1	1.5	1, 3
Ductwork indicated to be lined	All	All	D3	1	5
Ductwork indicated to be lined with 2-inch acoustic lining	All	All	D3 or D4	2	5
Single Wall Lined Plenums	All	All	D4	2	
Transfer Air Ducts	All	All	D3 or D9	1	
Exhaust Ductwork	Indoor	Concealed	D1	1.5	8
Exhaust Ductwork	Indoor	Exposed	D2	1.5	8
Kitchen Exhaust Ductwork	Indoor	All	D5	2-layers	
Plastic Piping and Ductwork within RA Plenums	Indoor	Concealed	D6	0.5	
Fire-Rated Ductwork Other than Kitchen Exh	Indoor	All	D7	1.5	
Boiler Breeching & Stack	Indoor	All	P1 or P2	3	
Boiler Breeching & Stack	Outdoor	Exposed	P1 or P2	3	4, 7

Notes:

1 Includes Supply Air Duct from Energy Recovery Units and Evaporative Coolers.
2 Provide acoustical liner as indicated on the drawings.
3 Delete Type D1 insulation if acoustical liner is indicated by plan notes or shown on the drawings.
4 Provide J1 Jacket.
5 In hospitals do not provide acoustical lining in supply ductwork or plenums downstream of the final filter.
6 Vaporseal ducts conveying cold air.
7 Seal outdoor ductwork to prevent ingress of moisture.
8 Insulate only the portion of exhaust ductwork between isolation damper and outside.

SECTION 230900 - FACILITY MANAGEMENT SYSTEM

PART 1 - GENERAL

1.1 REQUIREMENTS

A. The entire Facility Management System (FMS) specified hereafter shall be approved and listed by Underwriters' Laboratories, Inc., under UL 864 (Energy Management and Control System).

1.2 RELATED SECTIONS

A. Section 23 0500, Common Work Requirements for HVAC.

B. Section 23 0505, Piping Specialties.

C. Section 23 0523, Valves.

D. Section 23 0549, HVAC and Electrical Installation Coordination.

E. Section 23 0593, Testing, Adjusting and Balancing.

1.3 SCOPE

A. It is the intent of this Section to provide, install, connect, and calibrate the entire Facility Management System (FMS) as indicated on the Drawings and as necessary to provide fully automatic control for all systems as shown in the control drawings, stated in the sequences of operation, indicated in the electrical ladder diagrams, or as otherwise indicated in the Contract Documents. Some equipment controls may be specified to be provided in the Contract Documents outside this Section. As work of this Section, the Contractor shall coordinate with these other suppliers and trades to provide a completely integrated control system.

B. It is the responsibility of the bidder to read and conform to all sections of the Specifications, review all Contract Drawings of all Divisions, and coordinate with all equipment suppliers of material specified under other sections of the Specifications including any Owner-furnished equipment.

1. The engineering, installation supervision, programming, graphics development, calibration, startup, and checkout necessary for a complete and fully operational control system as specified hereafter shall be provided under this Section.

C. Provide startup documentation verifying proper operation of all points and all integrated systems.

D. Provide integration of variable refrigerant systems, packaged air handling units, into the FMS as outlined on the drawings, in the sequence of operations, or in the specifications.

E. Provide training and instruction of the installed control system.

1.4 APPROVED MANUFACTURERS

A. Facility Management System suppliers will be authorized factory representatives or branch offices of Automated Logic, Allerton Technologies, Johnson Controls, Trane, Siemens Building and Delta Controls.

1.5 SUBMITTALS

A. Within **[thirty (30)]** days of contract award, submit **[eight (8)]** sets of shop drawings and submittal data in accordance with Section 23 0500 and the General Contract Requirements. These submittals shall be delivered first to the mechanical and electrical sub-contractors for coordination review and evaluation prior to being submitted for final review. Letters from these sub-contractors verifying that they have reviewed the submittals, and any comments regarding the submittals, must be attached as part of the final submittal.

B. Submittals shall consist of shop drawings, catalog data sheets, and point verification forms as defined in the following paragraphs.

1. Shop drawings shall be provided which show all control devices, electrical ladder diagrams, control system schematics, sequences of operation, and a material list. All systems and the associated control components, as well as all connections between components, shall be clearly indicated. The submittal shall clearly indicate the required coordination with equipment supplied by others, including any Owner-furnished equipment. Simply showing a connection with no identification or termination will be considered unacceptable. All connections shown on the Drawings shall be labeled on both ends and these same labels shall be used for the installation process for ease of comparing the shop drawings to the actual field installation. Each control component shall be given a unique identifier. This identifier shall be used in the sequence of operation so that reference to the Drawings can be easily made. A complete FMS communication and power architecture drawing shall also be included on the shop drawing.

   a. Electrical ladder diagrams shall be shown on the shop drawings. Electrical ladder diagrams shall show all switches, relays, motor starters, etc. The electrical ladder diagrams shall show the correct control wiring and interlock wiring of all equipment provided under the Contract including any Owner-furnished equipment. Each diagram shall reference the correct power source by breaker panel and circuit number or from a control transformer. If equipment shown is provided by another Contractor, then this shall be noted.
   b. The sequence of operation for each controlled system shall be provided with reference to the control device identifier. The sequence of operation shall break down the control operation by major function (i.e., mixed air control, occupied-unoccupied, smoke purge, etc.,) and describe in detail the correct operation and interaction with other system functions. Use of the sequence of operation stated on the Drawings is acceptable; however, it shall be modified to reflect actual control device identifiers.
   c. A complete material listing shall be included on the shop drawings which show the device model numbers, device identifiers, quantities, manufacturers, etc., of all

equipment provided under this Section. The material list shall be organized in alphabetical order so that it can be easily compared to the associated catalog data sheets. The quantities are to be provided only to confirm a general understanding of the contract requirements and will not be verified as a complete material list.

2. Catalog data sheets will be provided for each different piece of equipment provided under this Section. At a minimum the data sheet shall contain sufficient information so that compliance with the Specification can be verified. Where multiple models or options are indicated on the same catalog data sheet, the equipment proposed shall be highlighted or otherwise indicated. The catalog data sheets shall be organized in alphabetical order to match the material listing on the shop drawings.
3. An integration plan shall be provided for each system being integrated into the FMS. The plan shall contain all systems, points, descriptions, addresses, and default values to be integrated. The contractor shall work with the system providers to compile this information prior to connection of the system to the FMS. This plan shall be submitted and approved by the Owner/Engineer before integration occurs.
4. Point verification forms shall be completed for all points that will be installed as part of the FMS. Once approved, these forms shall be used during the testing and startup portions of this work. A template point verification form is located at the end of this Section.
5. All Graphic Slides (or typical graphics for identical equipment) proposed for use on this Project shall be submitted for review and approval. The submitted slides shall be printed in color. All realtime display fields, user input fields, etc., shall be clearly indicated. No graphic software shall be installed on the job site until the Graphic Slides have been approved.
6. Software Development parameters including all trend logs, reports, point alarm parameters, passwords, and scheduling shall be submitted based on the contents of this Specification Section. The information contained in this portion of the submittal will be followed during development of the programming code and shall be used for evaluation of the system's performance during the commissioning phase.

    a. Report templates shall indicate what information will be presented on each report, how the information will be presented, report hard disk upload parameters, and report log file names.
    b. If user authentication is required in any part of the installed system blank forms shall be submitted for completion of user information by the Owner. The forms shall allow the Owner to fill in the operator's name and approved password level. During Owner training, the FMS programmers shall coordinate with the approved operators to allow the operators to input their private passwords.
    c. Blank schedule forms for each air handling system shall be submitted for completion by the Owner. Additionally, a blank schedule group form template shall be submitted so the Owner can identify schedule groups of HVAC equipment.

7. The names, phone numbers, e-mail addresses, job descriptions, pager numbers, mobile phone numbers, etc., shall be provided for the project manager, project engineer, project programmer(s), installation foreman, and any other individuals key to the completion of this project. If at any time during the project the assignment of personnel changes, the Owner and the Engineer shall be notified and the previously listed information shall be furnished for the newly assigned individuals.

C. All re-submittals shall contain a cover letter restating all of the previous submittal comments made by the reviewing engineer along with a written statement by the Contractor as to the resolution of each item. Any re-submittal issued to the engineer without this cover letter will result in an automatic rejection of the submittal.

1.6 RECORD DRAWINGS

A. Record drawings shall be provided as required by Section 23 0500 and the General Contract Requirements. Record drawings shall not be completed until after installation is complete. Any changes made during installation shall be recorded on the approved shop drawings as they are made so that a current record drawing is constantly being updated. These as-constructed drawings shall be available at all time for inspection by the Owner's Representative. At completion of the project, all manual changes shall be incorporated into a clean reproducible set of as constructed drawings. These as-constructed drawings shall be available for use during the training sessions.

B. With the reproducible record drawings the Contractor shall furnish a complete spare parts lists, operating instructions, and maintenance literature, for proper maintenance of all control equipment, in accordance with the requirement specified in Section 23 0500.

C. In addition to the record drawings, the following documents and manuals will be delivered to the Owner. Two (2) sets of these documents will be provided prior to training begins:

1. Names, address and 24-hour telephone numbers of Contractors installing equipment, and the control systems and service representative of each.
2. Operators Manual with procedures of operating the control systems including logging on/off, alarm handling, producing point reports, trending data, overriding computer control, and changing set points and other variables.
3. Programming Manual with a description of the programming language including syntax, statement descriptions including algorithms and calculations used, point database creation and modification, program creation and modification, and use of the editor.
4. Engineering, Installation and Maintenance Manual(s) that explains how to design and install new points, panels, and other hardware; preventative maintenance and calibration procedures; how to debug hardware problems; and how to repair or replace hardware.
5. A listing and documentation of all custom software created using the programming language including the point database. One set of magnetic media containing files of the software and database shall also be provided.
6. One set of electronic media containing files of all color-graphic screens created for the project.
7. Complete original issue documentation, installation, and maintenance information for all third party hardware provided including computer equipment and sensors.
8. Complete original issue media for all software provided including operating systems, programming language, operator workstation software, and graphics software.
9. Licenses and warranty documents for all equipment and systems.
10. Recommended preventive maintenance procedures for all system components including a schedule of tasks, time between tasks, and task descriptions.

D. Training Materials: The Contractor shall provide a course outline and training material for all training classes at least six weeks prior to the first class. The Owner reserves the right to modify any or all of the training course outline and training materials. Review and approval by Owner

and Engineer shall be completed at least 3 weeks prior to first class.

E. Operation and Maintenance Manuals: An updated as-built version of the control drawings and sequences of operation shall be included in the final equipment O&M manual submittal. The control drawings shall include:

1. A key to all abbreviations.
2. Graphic schematic depictions of the systems and each component.
3. Schematic system and component layout of any equipment that the control system monitors, enables or controls, even if the equipment is primarily controlled by packaged or integral controls.
4. A full points list with at least the following included for each point:

    a. Controlled system
    b. Point abbreviation
    c. Point description (dry bulb temp, airflow, etc.)
    d. Display unit
    e. Control point or setpoint
    f. Monitoring point
    g. Intermediate point
    h. Calculated point

5. Detailed sequences of operation for each piece of equipment. They shall include, as applicable:

    a. An overview narrative of the system (1 or 2 paragraphs) generally describing its purpose, components and function.
    b. All interactions and interlocks with other systems.
    c. Detailed delineation of control between any packaged controls and the building management system, listing what points the BMS monitors only and what BMS points are control points and are adjustable.
    d. Written sequences of control for packaged controlled equipment. Equipment manufacturers' stock sequences may be included. Provide additional narrative where needed.
    e. Start-up, warm-up mode, normal operating, emergency operating and shutdown sequences.
    f. Capacity control sequences and equipment staging.
    g. Temperature and pressure control: setbacks, setups, resets, etc.
    h. Detailed sequences for all control strategies, e.g., optimum start/stop, staging, optimization, demand limiting, etc.
    i. Effects of power or equipment failure with all standby component functions.
    j. Sequences for all level of alarms and emergency shut downs.
    k. Seasonal operational differences and recommendations.
    l. Initial and recommended values for all adjustable settings, setpoints and parameters that are typically set or adjusted by the operating staff; and any other control settings or fixed values, delays, etc. that will be useful during testing and operating the equipment.

F. After final occupancy and all debugging have occurred, the Contractor shall prepare two (2) copies of all control software on non-volatile magnetic media and deliver them to the Owner.

1.7 SYSTEM TESTING

A. The controls contractor shall prepare a written plan indicating in a step-by-step manner, the procedures that will be followed to test, checkout and adjust the control system prior to and during functional performance testing. At minimum, the plan shall include for each type of equipment controlled by the automatic controls:

1. System name.
2. List of devices.
3. Step-by-step procedures for testing each controller after installation, including:

    a. Process of verifying proper hardware and wiring installation.
    b. Written program of sequence for BAS devices and controllers
    c. Process of downloading programs to local controllers and verifying that they are addressed correctly.
    d. Process of performing operational checks of each controlled component.
    e. Plan and process for calibrating valve and damper actuators and all sensors.
    f. A description of the expected field adjustments for transmitters, controllers and control actuators should control responses fall outside of expected values.

4. A copy of the log and field checkout sheets that will document the process. This log must include a place for initial and final read values during calibration of each point and clearly indicate when a sensor or controller has “passed” and is operating within the contract parameters.
5. A description of the instrumentation required for testing.
6. Indicate what tests on what systems should be completed prior to Testing, Adjusting and Balancing (TAB) using the control system for TAB work. Coordinate with the Owner and TAB contractor for this determination.

B. Upon completion of the checkout of each controlled device, equipment and system prior to functional testing for each piece of equipment or system, provide a signed and dated certification to the Owner and GC that all system programming is complete as to all respects of the Contract Documents, except functional testing requirements.

C. List and clearly identify on the as-built duct and piping drawings the locations of all static and differential pressure sensors (air and water pressure).

D. At the termination of the testing period, the Contractor shall provide completed point verification sheets for each point in the FMS. These sheets shall be included as a part of the closeout notebook described in Section 23 0900-3.3-7. An example of a point verification form is included in Appendix C.

E. Trend logs and graphs shall be developed as described in Section 23 0900-3.3-7 and Appendices A and B. Completed trend requirements shall be compiled into organized notebook(s) and delivered to the Engineer for approval before the final inspection and close-out of the project is performed.

F. The Owner reserves the right to participate in or assign a representative to participate in the startup, testing, programming, or any other aspect of the construction of this project at no additional cost to the Owner.

1.8 TRAINING

A. The controls contractor shall have the following training responsibilities, in addition to any listed in Division 1:

1. The standard operating manual for the system and any special training manuals will be provided for each trainee, with three extra copies left for the Owner. In addition, copies of the system technical manual will be demonstrated during training and one copy submitted with each O&M manual. Manuals shall include detailed description of the subject matter for each session. The manuals will cover all written control sequences and have a definitions section that fully describes all relevant words used in the manuals and in all software displays. Manuals will be approved by the Owner. Copies of audiovisuals shall be delivered to the Owner.
2. The training will be tailored to the needs and skill-level of the trainees.
3. The trainers will be knowledgeable on the system and its use. For the on-site sessions, the most qualified trainer(s) will be used. The Owner shall approve the instructor prior to scheduling the training.
4. There shall be three training sessions:

a. Training I. Class Room. The first training shall consist of **8** hours of actual training. This training shall be held on-site. If held off-site, the training may occur prior to final completion of the system installation. Upon completion, each student, using appropriate documentation, should be able to perform elementary operations and describe general hardware architecture and functionality of the system.

b. Training II. Hands -On. The second session shall be held on-site for a period of **8** hours of actual hands-on training after the completion of system QA. The session shall include instruction on:

1) Specific hardware configuration of installed systems in this building and specific instruction for operating the installed system, including HVAC systems, lighting controls and any interface with security and communication systems.
2) Security levels, alarms, system start-up, shut-down, power outage and restart routines, changing setpoints and alarms and other typical changed parameters, overrides, freeze protection, manual operation of equipment, optional control strategies that CAN be considered, energy savings strategies and set points that if changed will adversely affect energy consumption, energy accounting, procedures for obtaining vendor assistance, etc.
3) All trending and monitoring features (values, change of state, totalization, etc.), including setting up, executing, downloading, viewing both tabular and graphically and printing trends. Trainees will actually set-up trends in the presence of the trainer.
4) Every screen shall be completely discussed, allowing time for questions.
5) Use of keypad or plug-in laptop computer.
6) Use of remote access to the system via phone lines or networks.

c. Training III. The third training will be conducted on-site six months after occupancy and consist of **4** hours of training. The session will be structured to address specific topics that trainees need to discuss and to answer questions concerning operation of the system.

1.9 SERVICE AND WARRANTY

A. The system supplier shall maintain a local maintenance support facility complete with system technicians, diagnostic and test equipment, and new spare components. Emergency service shall be available in the local office on a 24-hour, 7-day a week basis. The service agent shall provide a continuously monitored local service telephone number for emergency service and this number shall be provided to the Owner.

B. Warranty all work as follows:

1. Labor & materials for control system specified shall be warranted free from defects for a period of twelve (12) months after final completion acceptance by the Owner. Control System failures during the warranty period shall be adjusted, repaired, or replaced at no charge or reduction in service to the Owner. Service during this period shall be available within 12-hours from the time the trouble call is placed.
2. At the end of the final start-up/testing, if equipment and systems are operating satisfactorily to the Owner and Engineer, the Owner shall sign certificates certifying that the control system's operation has been tested and accepted in accordance with the terms of this specification. The date of Owner's acceptance shall be the start of warranty.
3. Operator workstation software, project specific software, graphics, database, and firmware updates shall be provided to the Owner at no charge during the warranty period. Written authorization by Owner must, however, be granted prior to the installation of such changes.
4. The system provider shall provide a web-accessible system and support on-line resource that provides the Owner access to a question/answer forum, graphics library, user tips, upgrades, and manufacturer training schedules.

1.10 OWNERSHIP OF PROPRIETARY MATERIAL

A. All project-developed hardware and software shall become the property of the Owner. These items include but are not limited to:

1. Project graphic images
2. Record drawings
3. Project database
4. Project-specific application programming code
5. All documentation

1.11 PROGRESS PAYMENTS

A. When developing a schedule of values for the FMS and control systems, a minimum of 20% shall be reserved for activities after construction completion, including commissioning support, testing (functional performance testing and trend logs as required herein), record drawings, training, etc. Payment for these activities may be requested as they are completed.

PART 2 - PRODUCTS

2.1 GENERAL

A. All products required for this project shall be selected in accordance with this part of the Section. Installation of the components shall be in accordance with Part 3 of the Section. If a component is required to meet the requirements shown on the Drawings and is not specified in the Part of the Specification, the supplier shall select and submit on components that meets all design requirements indicated on the Drawings, stated in the sequence of operation, and elsewhere in the Contract Documents.

2.2 PRIMARY OPERATOR WORKSTATIONS

A. One (1) primary operator workstation/ server shall be provided including all necessary hardware and software requirements described herein. The workstation shall be connected to the FMS local area network directly.

B. Hardware Requirements

1. The minimum hardware requirements for the operator workstation shall include the following minimum requirements but in any case shall be of adequate capacity to easily accommodate the FMS software:

    a. Desktop Computer with the latest Intel processor released in the past six months and a standard 102-key keyboard.
    b. 160.0 Gbyte hard drive, read/write DVD
    c. 256 Mbyte RAM minimum.
    d. High resolution 22" LCD monitor and graphics adapter with 16 Mbyte memory minimum.
    e. Serial Mouse or PS/2 Microsoft compatible mouse.
    f. ETHERNET® Card and USB ports.

2. One (1) color LaserJet printer shall be provided for connection to the primary operator workstation.
3. The primary operator workstation[s] shall be used only as an interface to the LAN and shall in no way be necessary for the routine functioning of the FMS local area network or any FMS controller operation.
4. Any and all additional interface equipment necessary to connect the Operator Workstation to the FMS network.

C. Software Requirements

1. The operating system for the operator workstation**[s]** shall be the latest version of Microsoft Windows released in the past six months.
2. Software shall be provided for the operator workstation**[s]** which will allow operators to conduct business on the LAN simultaneously with any FMS controller in a full multi-user mode of operation. The following requirements define the minimum features which shall be provided as part of the Scope of Work of this Section.

    a. Operator Interface

    The primary operator workstation interface software shall minimize operator training through the use of English language prompting, English language point identification, and industry standard PC application software.

    The operator interface shall minimize the use of a typewriter-style keyboard through the use of a mouse or similar pointing device, and "point and click" approach to menu selection. The users shall be able to start and stop equipment, change schedules, or change setpoints from graphical displays through the use of a mouse or similar pointing device.

    At the option of the user, operator workstations shall provide consistent graphical or text-based displays of all system point and application data described in this Specification. Point identification, engineering units, status indication, and application naming conventions shall be the same at all operator devices.

    The operator interface shall provide the ability to simultaneously view several different types of system displays in a windowing environment to speed facility operation and analysis. For example, the interface shall provide the ability to simultaneously display a graphic depicting an air handling unit, while displaying the trend graph of several associated space temperatures to allow the user to analyze system performance.

    User-definable, automatic log-off timers of from 1 to 60 minutes shall be provided to prevent operators from inadvertently leaving devices online.

    b. User Access

    Multiple-level password access protection shall be provided to allow the user/manager to limit workstation control, display and data base manipulation capabilities as he/she deems appropriate for each user, based upon an assigned password.

    A minimum of five (5) levels of access shall be supported and a minimum of 50 passwords shall be supported at each FMS panel.

    Operators will be able to perform only those commands available for their respective passwords. Menu selections displayed at any operator device, including portable or panel-mounted devices, shall be limited to only those items defined for the access level of the password used to logon.

    c. System Interaction

    The operator interface shall allow the operator to perform commands within any FMS controller on the FMS local area network including, but not limited to, the following:

    - Startup or shutdown selected equipment.
    - Adjust setpoints.
    - Add/modify/delete time programming.
    - Enable/disable process execution.
    - Lock/unlock alarm reporting for each point.
    - Enable/disable totalization for each point.

- Enable/disable trending for each point.
- Override PID loop setpoints.
- Enter temporary override schedules.
- Define holiday schedules.
- Change time/date.
- Enter/modify analog alarm limits.
- Enter/modify analog warning limits.
- View limits.
- Enable/disable demand limiting for each meter.
- Enable/disable duty cycle for each load.

All control strategies and energy management routines shall be definable by the operator. System definition and modification procedures shall not interfere with normal system operation and control.

The system shall be provided complete with all equipment and documentation necessary to allow an operator to independently perform the following functions:

- Add/delete/modify standalone FMS panels.
- Add/delete/modify operator workstations.
- Add/delete/modify application specific controllers.
- Add/delete/modify points of any type, and all associated point parameters, and tuning constants.
- Add/delete/modify alarm reporting definition for each point.
- Add/delete/modify control loops.
- Add/delete/modify energy management applications.
- Add/delete/modify time- and calendar-based programming.
- Add/delete/modify totalization for every point.
- Add/delete/modify historical data trending for every point.
- Add/delete/modify custom control processes.
- Add/delete/modify any and all graphic displays, symbols, and cross-references to point data.
- Add/delete/modify dial-up telecommunication definition.
- Add/delete/modify all operator passwords.
- Add/delete/modify alarm messages.
- Add/delete/modify all FMS programs operating within the FMS panels and system.

Definition of operator device characteristics, FMS panels, individual points, applications and control sequences shall be performed through fill-in-the-blank templates.

d. Reports

Reports shall be generated automatically or manually, and directed at operator input to either CRT displays, printers, or disk files. As a minimum, the system shall allow the user to easily obtain the following types of reports:

- A general listing of all points in the network.
- List all points currently in alarm.
- List of all off-line points.
- List all points currently in override status.
- List of all disabled points.
- List all points currently locked out.
- List of all items defined in a "follow-up" file.
- List all weekly schedules.

- List all holiday programming.
- List of limits and deadbands.

Summaries shall be provided for specific points, for a logical point group, for a user-selected group or groups, or for the entire facility without restriction due to the hardware configuration of the facility management system.

e. Third Party Interface

System data, including transactions, trends, alarms, totalization files, etc., shall be stored on the workstation disk drive in an industry standard database format (e.g., dBase IV) such that it is compatible with off-the-shelf third party database and spreadsheet programs.

f. Dynamic Color Graphic Displays

Color graphic site plans, buildings, building floor plan displays, and system schematics for each piece of mechanical equipment, including air handling units, chilled water systems, hot water boiler systems, and all other controlled or monitored systems shall be provided as specified in Part 3 of this Specification.

Dynamic point (actual or calculated) indication shall be shown in their respective locations, and shall automatically update to represent current conditions without operator intervention.

The windowing environment of the operator workstation shall allow the user to simultaneously view several graphics at the same time.

g. Graphic Generation Software

Graphic generation software shall be provided to allow the user to add, modify, or delete system graphic displays.

A complete standard library of pre-engineered screens and symbols depicting standard air handling unit components (e.g., fans, cooling coils, filters, dampers, etc.,) complete mechanical systems (e.g., constant volume-terminal reheat, VAV, etc.,) and electrical symbols.

The graphic development package shall use a mouse or similar pointing device in conjunction with a drawing program to allow the user to perform the following:

- Define symbols.
- Position and size symbols.
- Define background screens.
- Define connecting lines and curves.
- Locate, orient and size descriptive text.
- Define and display colors for all elements.
- Establish correlation between symbols or text and associated system points or other displays.

h. Database Save/Restore/Backup

Backup copies of all standalone FMS panel databases shall be stored in the operator workstations.

Continuous supervision of the integrity of all FMS panel databases shall be provided. In the event that any FMS panel on the network experiences a loss of its database for any reason, the system shall automatically download a new copy of the respective database to restore proper operation. Database backup/ download shall occur over the local area network without operator intervention. Users shall also have the ability to manually execute downloads of any or all portions of an FMS panel database to or from the operator workstation.

i. Trending and Trend Graphing

The software shall be capable of displaying realtime data from the FMS controllers or historical trend data retrieved from the operator workstation hard drive.

Capacity and features of the trending software and the associated trend graphing software shall be adequate to meet the requirements stated in Section 23 0900, 3.3 - 7 and as defined in Appendix A.

2.3 FMS CONTROLLERS

A. General

1. Standalone FMS controllers shall be microprocessor based, multi-tasking, multi-user, real-time digital control processors. Each standalone FMS controller shall consist of modular hardware with plug-in enclosed processors, communication controllers, power supplies, and input/output modules, volatile and non-volatile memory, signal conditioners, etc.
2. The FMS controllers shall have UL-916 or equivalent CSA or ETL listings. The FMS/FMS field modules shall also conform to FCC Docket 20780, Part 15, Subparagraph B.
3. The FMS controllers shall be fully compliant with ANSI/ASHRAE Standard 135-2004 BACnet and all published addenda at the time of installation.

B. Hardware Requirements

1. Communications

   a. Each FMS Controller shall be equipped with the necessary hardware to permit connection to the FMS local area network described in this Section. All communications hardware shall be part of the standard manufactured product and no intermediary devices to establish communications shall be permitted.

2. Memory

   a. Each FMS Controller shall have sufficient memory to support its own operating system and databases including:
      - Control processes.
      - Energy management applications.
      - Alarm management.
      - Historical/trend data for all points.
      - Maintenance support applications.
      - Custom processes.
      - Operator I/O.
      - Dial-up communications.
      - Manual override monitoring.

   b. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.

   c. Should FMS controller memory be lost for any reason, the panel will automatically receive a download via the local area network, phone lines, or connected computer. In addition, the user shall have the capability of reloading the FMS controller via the local area network, via the local RS-232C port, or via telephone line dial-in.

3. Input/Output

    a. Each FMS controller shall support inputs and outputs of the following types:
        - Type C digital inputs.
        - SPDT digital outputs.
        - Universal analog inputs which support all industry standard signals including 4-20 mA, 0-20 ma, 0-10 VDC, etc.
        - Universal analog outputs which support all industry standard signals including 4-20 ma, 0-20 ma, 0-10 VDC, etc.
        - Pulse Type C digital inputs.
        - SPDT pulsed digital outputs.

4. Communication Ports

    a. FMS controllers shall provide at least one RS-232C serial data communication ports for simultaneous direct connection of operator I/O devices including portable operator terminals (future) and printers. FMS controller shall allow connection to the serial ports without interrupting the normal operation of permanently connected modems, printers, or network terminals.

5. Override Switches

    a. Onboard hand/off/auto operator override switches shall be provided integral to the FMS controller for digital output points and positioning switches for all analog output points. The FMS controllers shall monitor the status or position of all overrides, and include this information in logs and summaries to inform the operator that automatic control has been inhibited.

6. Status Indicators

    a. The FMS controller shall have local status indication for each binary input and output without the need for an operator I/O device.

7. Surge and Transient Protection

    a. Isolation shall be provided at all network terminations, as well as all field point terminations to suppress induced voltage transients consistent with IEEE Standard 587-1980.

8. Expandability

    a. The system shall be modular in nature, and shall permit expansion through the addition of workstation hardware, FMS controllers, sensors, and actuators.

9. On-Line Diagnostics

    a. Each FMS controller shall continuously perform self-diagnostics, communication diagnosis and diagnosis of onboard electronics. The FMS controller shall provide both local and remote enunciation of any detected component failures or repeated failure to establish communication. Indication of the diagnostic results shall be

provided at each FMS controller, and shall not require the connection of an operator I/O device.

10. Power Failure Restart

    a. In the event of the loss of normal power, there shall be an orderly shutdown of all standalone FMS controllers to prevent the loss of database or operating system software. Upon restoration of normal power, the FMS controller shall automatically resume full operation without manual intervention.

C. Software Requirements

1. General

    a. All necessary software to form a complete operating system as described in this Specification.
    b. All software routines and programs specified in this Section shall be provided as an integral part of the FMS controller and shall not be dependent upon any higher level computer for execution.

2. PID Control

    a. The FMS controllers shall perform full proportional, integral, derivative (PID) control with all PID loops having the automatic control loop tuning feature.

3. Minimum Runtimes

    a. The control software shall include a provision for all digital outputs to have minimum on/off cycle filters.

4. Staggered Starts

    a. The control software shall include a provision for all digital outputs to electrical demand base start filters to prevent excessive electrical demand on the startup of equipment.

5. Automatic Restart

    a. After an interruption of normal power, the FMS controller shall analyze the status of all controlled equipment, compare it with the commanded position and return all equipment ON or OFF as necessary to resume normal operation.

6. Energy Management Applications

    a. The FMS controllers shall have the ability to perform all of the following energy management routines as standard sub-routines which do not require the application of customized software:
        - Time of day scheduling.
        - Calendar-based scheduling.
        - Holiday scheduling.

- Temporary schedule overrides.
- Optimal start.
- Optimal stop.
- Night setback control.
- Enthalpy switchover (Economizer).
- Peak demand limiting.
- Temperature compensated duty cycling.
- Chiller sequencing.

b. All programs shall be executed automatically without the need for operator intervention, and shall be flexible enough to allow operator customization. Programs shall be applied to building equipment as described in the Sequence of Operation.

D. Custom Programming

1. The FMS controllers shall be able to execute custom, job-specific processes defined by the operator, to automatically perform calculations and special control routines.
2. There shall be no restriction as to the ability of the operator to create any type of control logic using system inputs, calculated variables, Boolean Logic, etc.
3. The software shall be able to generate operator messages and advisories to operator I/O devices. A process shall be able to directly send a message to a specified primary operator station or printer, buffer the information in a follow-up file, or cause the execution of a dial-up connection to a remote operator workstation.

E. Alarm Management

1. Alarm management shall be provided to monitor, buffer, and direct alarm reports to operator devices and memory files. Each FMS controller shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic, and prevent alarms from being lost. At no time shall the FMS controller's ability to report alarms be affected by either operator activity at an Operator Workstation or local I/O device, or communications with other panels on the network.
2. The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of three (3) priority levels shall be provided. Each FMS controller shall automatically inhibit the reporting of selected alarms during system shutdown and startup. Users shall have the ability to manually inhibit alarm reporting for each point.
3. In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 65-character alarm message to more fully describe the alarm condition or direct operator response.
4. Each FMS controller shall be capable of storing a library of at least 250 alarm messages. Each message may be assignable to any number of points in the panel.

F. Report Routing

1. Alarm reports, messages, and files will be directed to a user-defined list of devices or disk files used for archiving alarm information.

G. Operator Log

1. Operator commands and system events shall be automatically logged to disk in personal computer industry standard database format. Operator commands initiated from direct-connected workstations, dial-up workstations, and local FMS controller network terminal devices shall all be logged to this transaction file. This data shall be available at the Operator Workstation. In addition, this transaction file shall be accessible with standard third party database and spreadsheet packages. The user shall also be able to define under which conditions point changes need to be acknowledged by an operator, and/or sent to follow-up files for retrieval and analysis at a later date.

H. Trend Analysis

1. The FMS controllers shall be capable of storing point history files for every analog and binary input and output at the same time. The point history routine shall continuously and automatically sample the value of all analog inputs at user definable intervals.
2. The FMS controllers shall also provide high resolution sampling capability in one-second increments for verification of control loop performance.
3. Trend data for the FMS controller as well as all associated ASCs and TCUs shall be stored at the FMS controllers, and uploaded to hard disk storage at the operator workstation when archival is desired. Uploads shall occur based upon either user-defined interval, manual command, or when the trend buffers become full. All trend data shall be available in disk file format compatible with third party personal computer applications.

I. Runtime Totalization

1. The FMS controllers shall automatically accumulate and store runtime hours for binary input and output points as specified in the Execution portion of this Specification.
2. The totalization routine shall have a sampling resolution of one (1) minute or less.
3. The user shall have the ability to define a warning limit for runtime totalization. Unique, user-specified messages shall be generated when the limit is reached.
4. The FMS controllers shall automatically sample, calculate and store consumption totals on a daily, weekly, or monthly basis for user-selected analog and binary pulse input-type points.

J. Event Totalization

1. Standalone FMS controllers shall have the ability to count events such as the number of times a pump or fan system is cycled on and off. Event totalization shall be performed on a daily, weekly, or monthly basis.
2. The event totalization feature shall be able to store the records associated with a minimum of 9,999,999 events before reset.
3. The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.

2.4 APPLICATION SPECIFIC CONTROLLERS

A. Each FMS controller shall be able to extend its performance and capacity through the use of remote Application Specific Controllers (ASC). The ASC shall be selected to match the function required. In no case shall multiple ASCs be used for one piece of mechanical

hardware or an entire system (HW or CW system) in an effort to increase point or memory capacity. If one ASC is unable perform all aspects of monitoring or control for any given piece of equipment or system, a FMS controller or more applicable ASC shall be applied.

B. Each ASC shall operate as a standalone controller on a sub-LAN and shall be capable of performing its specified control responsibilities independently of other controllers on the network. Each ASC shall be a microprocessor-based, multi-tasking, real-time digital control processor.

C. Each ASC shall have sufficient memory to support its own operating system and data bases for control routines, energy management applications, and operator I/O points.

D. The operator interface to any ASC point data or programs shall be through an operator workstation or from a portable operators terminal.

E. Power failure protection for all system setpoints, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the controller.

F. All ASC controllers shall be fully compliant with ANSI/ASHRAE Standard 135-2004 BACnet and all published addenda at the time of installation.

2.5 TERMINAL UNIT CONTROLLER

A. A Terminal Unit Controller (TUC) shall be provided for each terminal unit as indicated on the Drawings and as listed in the equipment schedule. The TUCs shall be connected as part of a LAN or sub-LAN which shall communicate at not less than 9600 Baud. Each terminal unit controller shall communicate on a peer-to-peer basis with all units having equal authority. Provide a TUC space temperature sensor for each TUC.

B. Each TUC shall execute application programs, calculations, and commands via a microcomputer resident on the TUC. The database and all application programs for each TUC shall be stored in readable/writeable non-volatile memory within the TUC.

C. Each TUC shall contain both software and hardware to perform full DDC/PID control loops. TUCs shall be able to provide analog output, in addition to normal binary type output.

D. Each TUC shall be able to support various types of zone temperature sensors, including temperature sensor only, temperature sensor with built-in local override switch, with setpoint adjustment switch.

E. Each TUC shall have a built-in detection circuit to monitor the presence of the power to the equipment, and in case of the absence of the power it shall generate on alarm to the Operator Workstation.

F. Each TUC shall have LED indication for visual status of communication, power, and all outputs. All circuits shall be optically isolated.

G. All TUC controllers shall be fully compliant with ANSI/ASHRAE Standard 135-2004 BACnet and all published addenda at the time of installation.

2.6 OPERATOR INTERFACE PANELS

A. The operator interface panel shall be a permanently mounted LCD display with keypad or touchscreen system. The LCD shall have a minimum of 80 characters on multiple lines. The operator interface panel shall connect directly to the FMS controller LAN or controller. Portable handheld devices shall not be approved.

B. The operator interface shall allow the operator to perform commands within any FMS controller on the FMS local area network including, but not limited to, the following:

- Startup or shutdown selected equipment.
- Adjust setpoints.
- Add/modify/delete schedules.
- Enable/disable process execution.
- Acknowledge alarms.
- Enable/disable totalization for each point.
- Enter temporary override schedules.
- Define holiday schedules.
- Change time/date.
- Enter/modify analog alarm limits.
- Enter/modify analog warning limits.
- View limits.
- Change password protection.

2.7 NETWORKING/COMMUNICATIONS

A. Primary Local Area Network (LAN)

1. The only FMS equipment connections to the primary LAN are the FMS controllers or routers and the operator workstations. All other FMS hardware shall reside on either the Controller LAN or the sub-controller LAN.
2. All FMS devices that reside on the primary LAN shall be compatible with the ETHERNET®.

B. FMS Controller Network (LAN)

1. FMS controllers (if not on the primary LAN) and application specific controllers Interfaces within a specific building shall reside on the second tier LAN referred to as the controller LAN. The controller LAN shall begin at the building FMS controller or router and extend to one or more FMS controller LAN controllers located throughout the building.
2. Access to system data shall not be restricted by the hardware configuration of the network. The hardware configuration of the network shall be transparent to the user when accessing data or developing control programs.
3. Expansion of the network shall support any combination of FMS controllers.

4. The network shall include provisions for automatically re-configuring itself to allow all operational equipment to perform their designated functions as effectively as possible in the event of single or multiple failures. The local area network shall also provide for error detection, correction, and re-transmission to guarantee data integrity.
5. Communications must be of a deterministic nature to assure calculable performance under worst-case network loading at speeds no less than 9600 bps. No collision-based network shall be accepted below 10 Mbps.
6. Automatic synchronization of the real-time clocks in all FMS controllers shall be provided.
7. Development of the controller LAN is work provided entirely under this Section of the Specification.

C. Sub-Controller Local Area Network

1. All lower level controllers associated with terminal unit controllers shall reside on the third tier LAN referred to as the sub-controller LAN.
2. The sub-controller LAN shall operate RS-485 at a selectable speed of 9.6K or higher. Development of the sub-controller LAN is work provided entirely under this Section of the Specification.

D. All products shall be new and of the latest manufacturer's design. Warranty of all products shall start on the date of final acceptance of the work.

E. All products shall be provided complete with all mounting hardware, brackets, and miscellaneous accessories whether stated in the individual product specification or not. Specific product options that are required to meet all design requirements indicated on the Drawings, stated in the sequence of operation, shown on the electrical ladder diagrams, and elsewhere in the contract documents shall be specified when the product is ordered and indicated on the catalog data sheet provided with the submittal.

2.8 DUCT STATIC PRESSURE STATION

A. Provide at each duct static pressure measuring location a traverse probe capable of continuous monitoring of static pressure. The probe shall contain multiple static pressure pickup points along the exterior surface of the cylindrical probe, internally connected to their respective averaging manifold. Each probe shall be extruded aluminum construction with threaded end support rod and nut, and mounting plate with gasket. Each probe shall be sized to span the entire duct and not extend past either side. The probe shall not produce a measurable pressure drop and shall produce a non-pulsating signal with an accuracy of 0.5 percent of total span. Air Monitor Model STAT-Probe/1 or equivalent.

2.9 OUTSIDE AIR STATIC PRESSURE PROBE

A. Outside air static pressure probe shall be constructed of 10 gage, anodized aluminum with a 2" diameter FPT connection. The probe shall be capable of sensing the outside atmospheric air pressure to within 2 percent of the actual value when subject to radial wind velocities up to 80 miles per hour with approach angles up to 30 degrees to the horizontal. Specification based on air monitor S.O.A.P.

2.10 ELECTRONIC DIFFERENTIAL PRESSURE TRANSMITTER

A. Electronic differential pressure transmitter shall be designed to measure the differential air pressure as indicated on the Drawings or as required. Pneumatic connections shall be 1/4" barbed and the enclosure shall be provided with holes for panel or field mounting. The output shall be a two wire 4-20 mA loop powered device with an input range as indicated in the Drawings but not more than twice the actual measure variable. The accuracy including linearity, hysteresis and repeatability shall be less than ±1 percent. Setra model C264 or equivalent.

2.11 ELECTRONIC TEMPERATURE ELEMENT AND TRANSMITTER

A. Zone Space Sensors

1. Each TUC or ASC controlling a single zone application shall be provided with a space temperature sensor. The space sensor shall include a thermistor packaged or RTD in the standard UC/sensor design, digital temperature display, timed override button, set point adjustment, and a maintenance communication port.

B. All Other Temperature Sensors

1. Thermistor temperature sensors connected to a TUC or an ASC shall be a Type II thermistor compatible with the attached FMS controller without the need for any signal conversion hardware. The accuracy of the thermistor shall be ±0.5 deg F over the range of the sensor. Precon ST series or equivalent.
2. RTD temperature sensors shall be 1000 ohm platinum having an accuracy of ±1 deg F over the entire range. The associated unit mounting transmitter shall generate a linear 4-20 mADC loop powered signal with a maximum input impedance of 675 ohms at 24 VDC.
3. Sensors used for mixed air application shall be 25' averaging type. The sensor span shall have a field set range of range of 32.0 deg F to 160.0 deg F.
4. All chilled water sensors and sensors placed in locations susceptible to condensation (outside or in chilled and condenser water liquid lines with the potential to drop below the ambient dew point) shall be furnished complete with a NEMA 3R enclosure for the electronics. The sensors shall have an immersion length of one half the pipe's diameter plus the length of the pipe tap. The sensors shall have a range of 10.0 deg F to +230.0 deg F. Units shall be furnished complete with a brass thermowell.
5. Duct temperature sensors for supply air temperatures and return temperature shall be a minimum of 18" in length. The sensor span shall have a range of -30.0 deg F to +160.0 deg F.
6. Sensors used for outdoor air temperature shall be provided complete with a sunshield. The sensor span shall have a range of -30.0 deg F to +140.0 deg F.
7. All immersion water, except chilled water sensors, shall have an immersion length of one half the pipe's diameter plus the length of the pipe tap. The sensors shall have a range of +10.0 deg F to +230.0 deg F. Units shall be furnished complete with a brass thermowell.
8. All temperature elements provided for space temperature measurement shall be installed in a white plastic housing.

2.12 AIR FLOW STATION AND TRANSMITTER

A. Pitot Tube Air Flow Element and Transmitter

1. Each airflow traverse probe shall contain multiple total and static pressure sensors located along the exterior surfaces of the cylindrical probe and internally connected to their respective averaging manifolds. The flow sensors shall not protrude beyond the surface of the probes, and shall be the offset type for static pressure and the chamfered impact type for total pressure measurement. The airflow sensing probe's measurement accuracy shall not be affected by directional flow having pitch and/or yaw angles up to 30 degrees. Each airflow traverse probe shall be of extruded aluminum construction and furnished with mounting plates(s), gasket, and signal fittings suitable for HVAC duct installation.
2. Total and static pressure sensors shall be located at the centers of equal areas (for rectangular ducts) or at equal concentric area centers (for circular ducts) along the probe length.
3. Probes shall be AMCA certified and be capable of measuring the airflow rates within an accuracy of ±2 percent without the use of correction factors. The maximum allowable unrecovered pressure drop caused by the probes shall not exceed 0.025 inches WC at 2000 fpm or 0.085 inches WC at 4000 fpm. The number of probes required for each installation shall be in accordance with the manufacturer's design recommendations. The airflow traverse probes shall be Air Monitor Corporation Model VOLU-probe or equivalent.
4. Pitot tube type air flow element flow stations shall not be used if the manufacturer's recommended upstream and downstream clearances cannot be achieved in the installation. The Contractor shall use thermal anemometer air flow stations in these instances.
5. The transmitter shall be capable of receiving flow signals from the airflow traverse probe and producing an output linear and scaled for air volume. The transmitter shall contain an integral multi-line digital display for use during the configuration and calibration process, and to display one transmitter output during normal operating mode. All transmitter configuration, parameter setting, zero and span calibration, plus display formatting and scaling will be performed digitally in the on-board microprocessor via input pushbuttons. The transmitter will be available in multiple natural spans covering the range of 0.05 inches WC to 25.0 inches WC with an accuracy of 0.25 percent of natural span. The transmitter shall be furnished with a transducer automatic zeroing circuit and be capable of maintaining linear output signals on applications requiring 5 to 1 velocity turndown. Transmitter shall have a NEMA 12 enclosure. This Specification applies to all airflow transmitters. Transmitter shall be Air Monitor VELTRON DPT 2500-plus or equivalent.

B. Thermal Anemometer Air Flow Station

1. The thermal anemometer air flow stations shall use instrument grade self heated Thermistor sensors with thermal temperature sensors. Flow measurement drift shall not exceed manufacturer's repeatability statement for the life of the equipment. The manufacturer shall provide test data for accuracy performance prior to bid date. Vortex shedding arrays are not acceptable. Auto zeroing sensors are not acceptable.
2. The flow station shall be duct mounted with glass encapsulated self-heated Thermistor and epoxy encapsulated temperature sensor. The sensor housing shall be constructed of Noryl with one to four probes (in accordance with the manufacturer's design guidelines). The support struts and support bracket shall be constructed of tubular aluminum.

3. The flow transmitter shall be totally solid state microprocessor based. The unit shall provide a separate analog signal averager for true averaging duct velocity output on ducts requiring multiple probes. The unit shall be 24 VAC powered, isolated from other devices and not grounded. Multiple series probes and averagers wired from a single transformer must be wired in phase. The flow transmitter shall have an aluminum enclosure.
4. The system shall operate over a temperature range of 30 to 160 degrees Fahrenheit. The system shall operate over a velocity range of 0 to 5000 FPM with a pressure drop of less than 0.005 inches WC at 2000 FPM. The unit shall have an accuracy of ±10 ft./min for flow rates less than 500 FPM and a ±2 percent of reading accuracy for flow rates greater than 500 FPM. The unit shall have a repeatability of ±0.2 percent of scale and resolution of 0.4 percent of scale. All electronics shall be housed in a NEMA 12 enclosure if the unit is mounted outside in the environment.
5. The unit shall have a field selectable output of airflow rate. Ebtron Eliminator Gold series, or equivalent.

2.13 ELECTRONIC HUMIDITY TRANSMITTER

A. The sensors shall have an accuracy of ± 3.0 percent R.H. over the range of 10 to 90 percent R.H. with an operating temperature range of at least -20 to 60 deg C. The transmitter shall output a 4-20 mADC loop powered signal over the full range of the transmitter and the input impedance shall not exceed 500 ohms at 20 VDC. The transmitter shall be specifically designed for use in measuring outdoor or duct humidity or indoor space applications as indicated.

1. Outdoor or duct mounted units shall be enclosed in a NEMA 4 enclosure with a black painted aluminum casing. Vaisala Model No. HMD 60 or equivalent.
2. Space transmitters shall be KELE Vaisala Model No. HMW 60 or equivalent.

2.14 CURRENT TRANSDUCERS

A. Current sensing transducers shall measure AC current of loads and shall output a 4-20 mADC signal over the measured range of 0 to 60 amps AC. Sensor shall have a minimum of 2.0 percent of full scale accuracy. Unit shall be split core design. Veris Industries Model H-921 or equivalent.

2.15 CURRENT SENSING SWITCH

A. Current sensing relays shall indicate the status of AC current of motor loads. The transistor switches shall be rated for switching controller DC current up to 0.1 amp continuously at 30 VDC. The setpoint of the contact operation shall be field adjustable from 1 to 135 amps AC. The switch shall be self powering with a switched load LED for local indication. Veris Industries Model H908 or equivalent.

2.16 AIR DIFFERENTIAL PRESSURE SWITCHES

A. Filter/Fan Status Switch

1. Air differential pressure switches shall have an adjustable setpoint of from 0.05" W.C. to 12.0" W.C. One snap acting SPDT Type C switch shall be enclosed under a NEMA 1 enclosure with a 1/2" conduit opening. Contacts shall be rated for 10 amps at 120 VAC. Cleveland AFS series or equivalent.

B. Static Pressure Safety Switch

1. Air pressure switch shall be manually reset type, designed to sense static pressure and break an electrical circuit when the setpoint is exceeded. The setpoint shall be adjustable form 0.4" to 12" W.C. Unit shall be furnished and installed with a static pressure tip. Kele & Associates Model AFS-460 or equivalent.

2.17 ELECTRIC LINE VOLTAGE THERMOSTAT

A. The thermostat shall be of the bimetallic design with a SPDT set of contacts rated for 120 VAC at 25 amps. Thermostat shall have an adjustable set point of from 50 deg F to 86 deg F with a fixed differential of 2.0 deg F. The cover shall be metal. Barber-Coleman Model No. TC-195 or equivalent.

2.18 ELECTRIC FLOW SWITCH

A. The switch shall utilize a multi-segment paddle for use in pipes ranging in size from 1" to 8" with a maximum operating pressure of 150 psig and utilize a sealed bronze bellows packless construction. A snap acting SPDT switch rated for 16.0 amps at 120 VAC shall be installed in a NEMA 1 enclosure with 1/2" conduit knockout is used for indoor applications. A NEMA 4 enclosure with threaded 1/2" rigid conduit connection is used in all outdoor or high humidity applications, on liquid lines handling fluids below ambient dewpoint or as indicated on the Drawings. Johnson F61 series or equivalent.

2.19 ELECTRIC LOW LIMIT (FREEZESTAT)

A. Freezestat shall have a 20' temperature-sensitive element designed to respond to the lowest temperature to which any 1' length of the element is exposed. The unit shall have an adjustable set point from 35 deg F to 45 deg F. The electrical rating of the two SPDT contacts shall be 10.2 full load amps at 120. Unit shall be complete with an external manual reset lever. Johnson A70 series or equivalent.

2.20 LIQUID DIFFERENTIAL PRESSURE SWITCH

A. Switch shall have an adjustable setpoint of from 0 to 150 psig and a minimum differential of 1 psig. One snap acting SPDT switch enclosed under a NEMA 4 enclosure with 1/2" conduit opening and rated for 5 amps at 120 VAC shall be provided. Kele & Associates Model 24-013 or equivalent.

2.21 CONTROL RELAYS

A. Control relay contacts shall be rated for 150% of the loading application, with self-wiping, snap-acting silver cadmium Form C contacts, enclosed in dust-proof enclosure. Relays shall be equipped with the necessary mounting base, DIN rail, labels, termination clips, etc., and a coil transient suppression devices. All relays for control by the FMS shall have 24 VAC coils. All other required relays shall have coil voltages appropriate for the installation. IDEC RH series or equivalent.

2.22 CONTROL TRANSFORMERS

A. Control transformers shall be provided where shown or where required to meet the sequence of operation. Control transformers shall be fused on both primary and secondary taps. Fusing shall not exceed 80 percent of the rated transformer output. Control transformers 100 VA and less may have internal secondary overload if desired but anything over 100 VA must be external fused. Control transformers over 100 VA supplying power to a control panel shall be located external to the control panel.

2.23 ELECTRIC-PRESSURE SWITCHES

A. The electric-pneumatic relay body shall be plastic with three 1/4" barbed connections. The body shall have holes for panel mounting and shall pass 0.2 SCFM at 15 psig. The coil power will be as required but no more than 120 VAC with a maximum power consumption of 6.5 watts. All electrical connections will be within a NEMA 1 enclosure. Barber Coleman Model No. Al-181 or equivalent.

2.24 PNEUMATIC PRESSURE GAUGES

A. Install all air pressure gauges on air lines to and from all thermostats (except room type), valves, air motors, controllers, and as shown on the Drawings, so that the operation of each air control device can be checked. Provide all gauges no less than 2" except where a gauge is furnished inside the case of an instrument with its face showing through the instrument case as an integral part of the manufacture of the instrument.

2.25 AUTOMATIC DAMPERS

A. All automatic dampers, except for mixing box dampers furnished with air handling units as specified on the Equipment Schedule, shall be furnished under this Section of the Specifications. These dampers shall be installed and mounted under Section 23 3000.

B. Dampers shall be constructed of extruded aluminum with oilite bronze or Teflon bearings and trunnions of non-corrosive materials. Each blade shall have a positive closing butyl-rubber or neoprene edge seal, and spring-loaded side seals unless otherwise noted. Dampers shall have louvers designed so that the blades are interconnected to give parallel movement. Jack shafting shall be provided for all dampers greater than 24" by 24". Ruskin CD-50 or equivalent.

C. Parallel Blade Dampers: Provide parallel blade type automatic dampers for return air dampers, two-position dampers, the face section of face and bypass dampers, and where indicated on the Drawings.

D. Opposed Blade Dampers: Provide opposed blade type dampers for volume control, exhaust and outside air dampers of a mixing section, throttling application and where indicated on Drawings.

2.26 DAMPER ACTUATORS

A. Electronic Damper Actuators

1. The actuator shall be of the direct-coupled design. The fastening clamp assembly shall be of a V-bolt design with associated V-shaped toothed cradle attaching to the shaft for maximum strength and eliminating slippage. Spring return actuators shall have a V-clamp assembly of sufficient size to be directly mounted to an integral jack shaft of up to 1.05 inches when the damper is constructed in this manner. Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuator's rated torque and shall have a two (2) year manufacturer's warranty, starting from the date of installation.
2. The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the entire rotation of the actuator. Mechanical end switches or magnetic clutch to deactivate the actuator at the end of rotation are not acceptable. For power-failure/safety applications, an internal mechanical spring return mechanism shall be built into the actuator housing. Non-mechanical forms of fail-safe operation are not acceptable.
3. Spring return actuators shall be provided for all outside and exhaust/relief air dampers in addition to all locations indicated on the Drawings. Spring return actuators shall be capable of both clockwise and counterclockwise spring return operation by simply changing the mounting orientation.
4. Proportional actuators shall accept a 0 - 10 VDC or 0 - 20 mA control input and provide a 2 - 10 VDC or 4 to 20 mA operating range. All actuators shall provide a 2 - 10 VDC position feedback signal and shall have an external, built-in switch to allow the reversing of direction of rotation.
5. All actuators shall not require more than 10 VA regardless of the operating voltage.
6. All non-spring return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 60 in/lb torque capacity shall have a manual crank.
7. Actuators shall be provided with a conduit fitting and a minimum three-foot electrical cable and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections.
8. Actuators shall be Underwriters' Laboratories Standard 873 listed and Canadian Standards Association Class 481302 certified as meeting correct safety requirements and recognized industry standards.
9. Manufacturer shall be ISO9001 certified. Actuators shall be manufactured by BELIMO or equivalent.

2.27 CONTROL VALVES

A. Ball Control Valves Three Inches and Less.

1. Two-way control valves shall be industrial quality with bronze bodies and female NPT threads. Valve bodies may also be stainless steel, titanium or nickel with operating pressure up to 2000 psi. The maximum operating differential shall be 5 psi for water.
2. All valves shall have blowout proof stem design, glass-reinforced Teflon thrust seal washer and stuffing box ring with minimum 600 psi rating. Stem packing gland screw shall be adjustable for wear.
3. Standard chromium plated stainless steel ball and stem, shall be rated at a minimum of 600 psi WOG (water-oil-gas), cold, non-shock, and 150 psi for saturated steam service. All valves shall be provided with reinforced Teflon seats.
4. Belimo, Bray, or equivalent.

B. Two- and Three-Way Globe Control Valves Two Inches and Less.

1. Valves 1/2" through 2" shall be bronze, screw type, and shall be rated at 250 psi maximum working pressure for water and steam.
2. Valve stems shall be stainless steel, highly polished, corrosion-resistant, alloy to decrease friction and increase response. Valve plugs shall be brass and guided to ensure perfect seating.
3. Stem packing shall be spring loaded EP V-rings for water applications and Teflon V-rings for steam applications to eliminate leakage around the stem and ensure a minimum amount of stem friction. Stem lift shall be 1/2" to 3/4".
4. Flow type shall be equal percentage for water. The maximum operating differential shall be 5 psi for water.
5. Composition discs shall be replaceable and provide tight shutoff.
6. Belimo, Bray, or equivalent.

C. Two- and Three-Way Globe Control Valves Greater than Two Inches.

1. Valves 2-1/2" through 6" shall be cast iron flanged, and rated at 125 psi maximum working pressure. The maximum working temperature shall be 300 deg F/149 deg C.
2. Valve plug stems shall be stainless steel, highly polished, corrosion-resistant, alloy to decrease friction and increase response. Valve plugs shall be brass and guided to ensure perfect seating. Stem packing shall be Teflon, spring loaded EP V-rings to eliminate water leakage around the stem and ensure a minimum amount of stem friction. Lift shall be 3/4" to 1-1/2".
3. Flow type shall be equal percentage. The maximum recommended differential shall be 5 psi. Composition discs shall be replaceable and provide tight shutoff.
4. Belimo, Bray, or equivalent.

D. Control Butterfly Valves

1. Valve body shall be of the full lug-wafer style, drilled and tapped for isolation and removal of downstream piping. Flanges shall meet ANSI 125 and 150 standards. The body shall feature an extended neck allowing for sufficient clearance for flanges and piping insulation. The cast-in top plate shall allow for direct mounting of all actuators.
2. The disc and hub edge shall be rounded and hand polished to a 32 AARH or better finish to protect seats from damage and to reduce frictional torque. The disc shall have a full 360 degree concentric seating, minimum flow restriction and self-locking stainless steel disc to stem screws for quick and easy disassembly. A torque plug shall provide a positive leak-proof connection of the disc to the stem.

3. Valves shall feature a single, through-shaft design for high strength and positive disc control.
4. The seat shall be heavy duty with molded-in O-rings creating a positive seal between flange face and valve body. No gaskets shall be required between the valve and flange faces. The resilient seat shall provide a bubble-tight shutoff in either direction with the disc closed. Seat design shall isolate the body and stem from the flowing media. The seat shall not be bonded to the valve body and shall be easily replaceable in the field.
5. The primary steam seals shall be formed by preloaded contact of the disc hub with flatted seat surfaces. The secondary stem seal shall be formed by an engineered interference fit (stem diameter larger than stem passage hole) of the stem through the seat. An internal bi-directional stem seal, located in the upper journal, shall be self-adjusting and support full vacuum and pressure to prevent contamination of the stem area and act as a tertiary seal to line pressure.
6. The top bushing, located in the upper journal, shall be non-corrosive and heavy duty to absorb actuator side thrust. Upper and lower non-wetted, metal inboard stem bearings shall be isolated from the flow media.
7. All valves are factory tested to 10 percent of specified pressure rating. The lugged version is rated for 50 psi dead-end service for removal of downstream piping.
8. Belimo, Bray, or equivalent.

2.28 CONTROL VALVE ACTUATORS

A. Electronic Globe and Ball Valve Actuators

1. Ball valves actuator shall be fully modulating using 2-10 VDC or 4-20 mADC, floating point, two-position spring return as indicated in the control sequence. Fail safe, where specified, shall require mechanical spring return. The actuator shall be positive positioning, responding to a 2-10 VDC or 4-20 mA signal (with the addition of a 500 ohm resistor). There shall be a visual valve position indicator and an actuator generated 2-10 VDC valve position output signal for electronic feedback to the controller. The actuator shall have two auxiliary contacts. Power shall be 24 VAC unless indicated otherwise on the Drawings and shall not exceed 8 watts at 24 VAC. A 3-foot cable shall be provided for easy installation to an electrical junction box. The actuator shall provide minimum torque required for proper valve close-off, with an approximate running time of two (2) minutes for full rotation. The actuator shall be designed with current limiting motor protection. (End of travel switches and magnetic clutches are not acceptable.) A release button on the actuator shall be provided to allow for manual override, except when utilizing spring return actuators.
2. Ball Valves: All actuators shall be UL listed. The manufacturer shall warranty all the actuators and valve assemblies for a period of two (2) years from date of installation.
3. The actuators and valves shall be factory mounted and tested and supplied. Belimo, Bray, or equivalent.

B. Electronic Butterfly Valve Actuators

1. Actuators shall have a single phase permanent split-capacitor reversible motor with 120 VAC power. The motor shall contain a built-in UL approved automatic reset thermal overload protector embedded in the motor windings. Actuators shall be designed for butterfly valves or ball valves. Use of modified damper type actuators shall not be accepted.

2. All travel switches shall be single pole, double throw, form C type rated for 10 A at 125 VAC. Travel limit switches shall limit the actuator in both the open and closed position.
3. Mechanical stainless steel travel stops shall be located outside the actuator for ease of adjustment and contain stainless steel lock nuts to hold the travel stops in place.
4. All units shall be equipped with an aluminum manual override hand wheel to rotate the valve without electrical power and disengage power if power is still applied to the valve. The override assembly shall ensure positive and fast manual operating without the use of extra tools.
5. The actuator enclosure shall be certified to UL, CSA, & CE waterproof standards NEMA 4.
6. Modulating actuators shall be positive positioning, responding to a 4-20 mA or 0-10VDC signal with a modulating 4-20 mA output from the valve indicating actual valve position.
7. Provide open and closed end switches for status feedback on all two-position valves.
8. The actuators and valves shall be factory mounted and tested and supplied. Belimo, Bray, or equivalent.

2.29 ELECTRIC TO PNEUMATIC (EP) TRANSDUCERS

A. Electric-pneumatic transducer input signal (i.e., 4-20 mA, 0-10 VDC, etc.,) shall be matched to the linear 3 to 15 psig output signal. The transducer shall have pressure calibration adjustment and allow manual adjustment of the pneumatic output signal. The unit shall be designed to mount on either a DIN rail or directly on the control panel backplane. The unit shall be equipped with a branch pressure gauge and shall have an internal main airline filter equivalent to Balston Model No. 9933-03-BQ. KELE Model UCP-422 or equivalent.

2.30 ELECTRICAL CONTROL POWER AND LOW VOLTAGE WIRING

A. Provide interlock wiring between supply and exhaust fans, electrical wiring for relays (including power feed) for temperature and pressure indication. Provide interlock wiring between refrigeration machines, pumps and condensing equipment as required for the specified sequence of operation and the refrigeration system integral controller(s). Do not provide interlock wiring if a dedicated digital output has been specified for the equipment or the sequence of operation requires independent start/stop.

B. Provide power wiring, conduit and connections for low temperature thermostats, high temperature thermostats, alarms, flow switches, actuating devices for temperature, humidity, pressure and flow indication, point resets and user disconnect switches for electric heating, appliances controlled by the FMS.

C. Provide all other wiring required for the complete operation of the specified systems including control power wiring not expressly stated to be provided by Division 26.

D. Install all wiring raceway systems complying with the requirements of the National Electrical Code and Division 26. All installations shall be installed in EMT.

E. FMS Network Communication Requirements

1. Wired network communication shall be via channels consisting of communications wire installed in a 3/4" EMT.

2. Telephone lines, where required as a remote communication source, shall utilize voice band, non-switched, private line channels consistent with Bell Systems Technical Reference Publication 41001 and shall be four-wire unconditioned 3002 channels. The modems shall have 25 pin EIA connectors and RS-232C interface.
3. Communication conduits and wiring shall not be installed closer than six feet from high power transformers or run parallel within six feet of electrical high power cables. Care shall be taken to route the cable as far from interference generating devices as possible.
4. All shields shall be ground (earth ground) at one point only, to eliminate ground loops.
5. There shall be no power wiring, in excess of 30 VAC rms, run in conduit with communications wiring. In cases where signal wiring is run in conduit with communication wiring, all communication wiring and signal wiring shall be run using separate twisted shielded pairs (24 AWG) with the shields grounded in accordance with the manufacturer's wiring practices.

F. Power and Communication Wiring Transient Protection

1. The control manufacturers shall submit catalog data sheets providing evidence that all FMS products offered by the manufacturer are tested and comply with the standard for Transient Surge withstand capabilities for electrical devices ANSI C62.41, IEEE-587-1980, Categories A and B. Such testing shall have included power and communication trunk wiring. Compliance with IEEE-587 shall imply conformance with IEEE-472 transient standards based on the stated position of ANSI and IEEE regarding applicability of the rated standards.
2. Communications trunk wiring shall be protected with a transient surge protection device providing the minimal protection specifications of the General Semiconductor, Model #422E device.
3. The communications circuitry, input/output circuitry, and CUs, shall provide protection against a 1000 volt, 3 amp transient signal, directly applied to the communication or input/output terminations. The manufacturer’s catalog data sheet shall provide evidence of conformance with this requirement. Systems not complying with this requirement shall provide equivalent protection external to the FMS controller. Protection shall be provided for the individual communications and input/output terminations for each FMS controller. Submittal documentation shall clearly define how this requirement will be met and how the external protection will not affect the performance of the controllers.

G. Input/Output Control Wiring

1. RTD wiring shall be three-wire or four-wire twisted, shielded, minimum number 22 gage.
2. Other analog inputs shall be a minimum of number 22 gage, twisted, shielded.
3. Binary control function wiring shall be a minimum of number 18 gage.
4. Analog output control functions shall be a minimum of number 22 gage, twisted, shielded.
5. Binary input wiring shall be a minimum of number 22 gage.
6. Thermistors shall be equipped with the manufacturer's calibrated lead wiring.
7. 120V control wiring shall be #14 THHN in 3/4" conduit. Provide 4 or 20 percent fill extra wire in each conduit.

H. Splices

1. Splices in shielded cables shall consist of terminations and the use of shielded cable couplers which maintain the integrity of the shielding. Terminations shall be in accessible locations. Cables shall be harnessed with cable ties as specified herein.

I. Conduit and Fittings

1. Conduit for Control Wiring, Control Cable and Transmission Cable: Electrical metallic tubing (EMT) with compression fittings, cold rolled steel, zinc coated or zinc-coated rigid steel with threaded connections.
2. Outlet Boxes (Dry Location): Sheradized or galvanized drawn steel suited to each application, in general, four inches square or octagon with suitable raised cover.
3. Outlet Boxes (Exposed to Weather): Threaded hub cast aluminum or iron boxes with gasket device plate.
4. Pull and Junction Boxes: Size according to number, size, and position of entering raceway as required by National Electrical Codes. Enclosure type shall be suited to location.

2.31 SMOKE AND FIRE DETECTORS

A. Smoke detectors shall be supplied, powered, installed, and interlocked in accordance with Section 23 0549. The smoke detectors shall be listed by Underwriters' Laboratories, Inc. The units shall be designed for detection of combustion gases, fire and smoke in air conditioning and ventilation system ducts, in compliance with the National Fire Protection Association, Recommended Practices Pamphlet No. 90A. It shall consist of an ionization type detector with self-contained control unit. The assembly shall consist of a casting to accommodate metallic sampling tubes which extend across the duct of the ventilation system.

B. The unit shall provide two (2) sets of normally open single pole, double throw alarm operated relay contacts (5A, 120V, AC).

C. The unit shall be bolted directly to the duct or plenum wall. A template shall be provided for making necessary cutouts and holes. Complete instructions shall be provided with units.

D. Unit shall be capable of stable operation from 0 deg to 150 deg F.

E. Sampling tubes shall be EMT tubing, 1/2-inch in diameter, length and support as required to extend across plenum or duct. Quantity and location of sampling tubes shall be as required for representative sampling. Plastic tubes will not be allowed.

2.32 TEMPERATURE CONTROL PANELS

A. Control panels shall be provided as required for mounting of system control devices as indicated on the Drawings. Panel shall be sized as required to accommodate controls with hinged door, key lock. Panel shall be constructed of metal with metal mounting backplanes. All panels shall be supplied with the same key. All panels shall be NEMA rated and UL listed. Hoffman or equivalent.

2.33 REFRIGERANT VAPOR DETECTOR

A. The gas monitoring system shall continuously measure and display the specified gas concentration of the chillers. The system shall provide visual indicators when preset limits are exceeded. Relay output for alarms and control shall be provided.

B. The system shall consist of a control module with remote sensing modules.

1. The sensor module shall conform to the following:

   a. NEMA 4X enclosure
   b. Photoacoustic IR sensor.
   c. Five LED status indicators.
   d. 120 VAC powered.
   e. Single channel diffusion sampling.
   f. 20 PPM detection limit.

2. The control module shall conform to the following:

   a. NEMA 4X enclosure.
   b. 4-20 mA output.
   c. Accepts up to 8 remote sensor inputs over a single pair communications cable.
   d. Digital display.
   e. Three levels of alarm and fault indicators with relay outputs.
   f. System configuration via the front panel keypad.
   g. 85 Db audible alarm with an acknowledge switch.
   h. 120 VAC powered.

C. Operating Principle: The principle of operation shall be of the infrared photoacoustic absorption type.

1. Analyzer Sensitivity: The analyzer limit of detection for all refrigerants shall be 20 PPM.
2. Analyzer Linearity: The analyzer shall be within +/- 5 PPM of a linear response in the range of 0-100 ppm and +/- 5% of full scale in the range of 100-1000 ppm.
3. Stability: The 24 hour zero or span drift must be less than 5 PPM. The long term (1 year) zero drift shall be less than 5 PPM. The term span drift shall be less than 10 PPM.

D. Calibration: The calibration shall be performed using standard RP cylinders and existing calibration equipment.

E. Monitor Unit Requirements

1. Readout Displays: A 2 line x 20 character alpha numeric display shall be provided for the purpose of displaying the gas concentration, diagnostics, set-up and calibration menu.
2. Visual Alarm Indicators: All alarm indications shall be displayed on the front panel display.
3. Alarm Set Point Levels: Three separate alarm set point levels shall be provided. The set points shall be independently adjustable for any value for a given range. The set points shall provide drive signals to user interface relays. The alarm set points shall have the capability of providing the user a selection of latching or non-latching.

4. Relay Outputs: The alarm set point drive signals shall activate user relays as follows:

    a. Number of Relays: As a minimum, one relay for each alarm set point level shall be provided.
    b. Contact Rating: All relays shall be Form C, single pole, double throw. Dry contacts shall be rated for 8 amps resistive at 120 VAC.
    c. Contact Selection: The contacts shall be capable of being selected normally energized or non-energized, latching or non-latching.
    d. The trouble relay is normally energized and closed for normal conditions. If a system fault is detected, the trouble relay will de-energize.

5. Malfunction Indication: The readout display described in Paragraph above shall display full diagnostics when a fault exists without the use of codes.
6. Audible Alarm: An audible buzzer is included; it sounds when one of the three pre-selected alarm conditions or a trouble condition occurs.
7. Front Panel Controls: The function listed in this paragraph shall be accomplished using a keypad readily accessible on the front panel. No tool or special adapters shall be used for display of alarm set point level on the readout display or resetting any alarm set point or zero and span calibration adjustments.
8. Output Signals: The system shall be capable of supplying a 4-20 mA isolated sourcing signal and 0-10 VDC, signal representing the gas concentration being sampled.

F. System Power Requirements: The system shall operate on 115 or 220 VAC.

G. Maximum System Maintenance Requirements: The system shall require no periodic maintenance other than periodic checking. Periodic checking or adjustments of the unit shall be capable of being accomplished by one person at the unit location.

H. Manufacturer Capability Requirements: As a minimum, the Gas Monitoring Equipment manufacturer must be capable of supplying all equipment used to check or calibrate the unit. They also must be capable of providing on site service with factory trained personnel and be capable of providing start-up assistance and training for the owner/operator.

I. The Gas Monitoring System shall be tested, approved, and certified by UL to the standards of UL 2075, including performance testing, and shall be listed and labeled accordingly.

J. Gas Monitoring System shall be a Mine Safety Appliances Company Chillgard L-Series Refrigerant Monitor or equal performance approved by the engineer.

2.34 CARBON DIOXIDE SENSOR

A. The carbon dioxide sensor shall be specifically designed to generate a linear 0-10 VDC or 4-20mA signal proportional to a 0-2000ppm CO2 level in the duct. The unit shall have an accuracy of +/-2% of full scale up to 1400ppm and a selectable auto-calibration mode. Sensor shall have a minimum of 5 year warranty. SENVA Sensors C02D or equivalent.

2.35 EQUIPMENT CONNECTIONS

A. Not Applicable.

2.36 ELECTRONIC LIQUID DIFFERENTIAL PRESSURE SENSOR

A. Electronic differential pressure transmitter shall be designed to measure the differential liquid pressure as indicated on the Drawings or as required. Liquid connection shall be 1/4" NPT and the enclosure shall be NEMA 4 with 1/2" conduit knockouts. The output shall be a two wire 4-20 mA loop powered device with an input range has indicated in the Drawings but not more than twice the actual measure variable. The accuracy including linearity, hysteresis and repeatability shall be less than or equal to ± 0.25% of full scale. Setra Model C230 or equivalent.

2.37 ELECTRONIC LIQUID PRESSURE SENSOR

A. Electronic pressure transmitter shall be designed to measure the liquid gauge pressure as indicated on the Drawings or as required. Liquid connection shall be 1/8" NPT. The unit shall have an accuracy of ± 0.13% of full scale. The unit shall have stainless steel media. Setra Model C206 or equivalent.

2.38 INDOOR STATIC AIR PROBE

A. Indoor static air probes shall be provided for each indoor air pressure measurement location. They shall be flush mounted with a concealed connection. They shall be constructed of 10 gage aluminum with a 1/8" coupling for output signal connection. Air Monitor S.A.P. or equivalent.

2.39 BOILER REMOTE SHUTDOWN SWITCH

A. The emergency shutdown switch or circuit breaker must be sufficient to disconnect all power to the burner controls. It shall be constructed in a manner that safeguards it against tampering. The switch and installation shall comply with the National Electric Code, NFPA No. 70 and ASME CSD-1 CE-110.

2.40 ELECTRONIC HVAC LIQUID FLOWMETER

A. Insertion Electromagnetic Type

1. The flowmeter shall be of the insertion electromagnetic type which penetrates into the line. The flowmeter shall be furnished complete with a flow transmitter which supplies a 4-20 mA or 0-10 VDC signal for flow. Meter shall have an accuracy of no less than 1% of the actual reading over the range of the meter. Meter shall include all necessary equipment to allow the flow meter to be inserted or removed without draining the system. Flow meter shall be installed within the manufacturer’s required straight pipe lengths for accuracy. If the location of the insertion meter cannot meet these requirements, then the Inline Electromagnetic Type meter shall be used. Flow meter shall be Onicon F-3500 or equivalent.

B. Inline Electromagnetic Type

1. The flowmeter shall be of the inline electromagnetic type which installs into the line.

The flowmeter shall be furnished complete with a flow transmitter which supplies a 4-20 mA or 0-10 VDC signal for flow and remote digital display. Meter shall have an accuracy of no less than 1% of the actual reading over the range of the meter. Meter shall be 24 VAC powered. Meter shall be Meter shall include all necessary gaskets required for installation into the system. Flow meter shall be installed within the manufacturer's required straight pipe lengths for accuracy. Flow meter shall be Onicon F-3200 or equivalent.

2.41 DOMESTIC WATER SUB-METER

A. The domestic water/irrigation flow meters shall include a supply flow sensor/ transmitter, supply pressure sensors/ transmitters, strainer, and wells as specified below. The meter shall have a local readout of flow. The meter and transmitters shall be utilize an input power of 24 VDC and shall provide a pulse output of totalized flow and a 4-20mA output signal for instantaneous flow and pressure. The meter and transmitters shall be suitable for operation in a mechanical room atmosphere in a 32 to 185 degrees F range. The meter and transmitters shall indicate the latest factory calibration and shall be tagged with abrass tag indicating service, building number, and calibration range. All transmitter enclosures shall be NEMA 4 with two 3/4" electrical hubs with plugs.

B. The flow sensor shall be an inline turbine type flow meter indicating flow in GPM. The maximum pressure drop across reduced-size meter assembly at maximum design flow shall be 1.8 psi. The flow sensor shall have an accuracy of +/- 1.5% of flow across the full range for the given pipe size. The meter shall operate over the temperature range of 40 to 100 degrees F and a pressure range of 0 to 100 psig. The meter housing shall be cast bronze with all internal pieces made of durable material such as thermoplastic or stainless steel. All bearings shall be self-lubricating. The transmitter shall have both an instantaneous flow and totalized flow output. A local totalization display shall be provided indicating instantaneous flow in GPM and totalized flow in gallons. The flow sensor shall be furnished with a strainer on the utility side of the meter. The strainer shall be provided so as to provide ease of maintenance. Flow sensor and transmitter shall be Turbo Badger Meter or prior approved equivalent.

2.42 GAS SUB-METER

A. The flow meter shall be hand-insertable up to 250 psi. Materials of construction for wetted metal components shall be 316 SS. The flow meter shall provide SFPM flow readings from a pair of encapsulated platinum sensors and shall not require additional temperature or pressure compensation. In addition, the meter shall continuously display information that can be used to validate the calibration of the meter. Each flow meter shall be individually wet-calibrated against a standard that is directly traceable to NIST*. A certificate of calibration shall be provided with each flow meter. Provide flow meter assembly complete with all installation hardware necessary to enable insertion and removal of the meter without system shutdown.

B. Accuracy shall be within ± 1% of rate from 500-7000 SFPM and ± 2% of rate from 100-500 SFPM. Overall turndown shall exceed 1000:1. Output signals shall consist of the following: (1) analog 4-20mA output and (1) scalable pulse output for totalization. The meter shall be equipped with an integrally mounted graphical display that may be optionally remote mounted up to 1000 ft from the sensor. Each flow meter shall be covered by the manufacturer's two-year warranty. Provide an ONICON Model F-5100 Insertion Thermal Mass Flow Meter or

equivalent. Meter shall be rated for outdoor application.

PART 3 - EXECUTION

3.1 GENERAL

A. All devices, conduit, wiring, etc., shall be installed in a neat professional manner by skilled persons.

1. The installation of all aspects of the system shall comply with all applicable codes and regulations and with Division 26 Specifications.
2. The installation of all materials shall be in accordance with the published manufacturer's recommendations without exception. If for some reason a particular component cannot be installed in compliance with these recommendations, the Contractor shall advise the Engineer of the situation.
3. Where miscellaneous materials are required to complete an installation, i.e., isolation valves for pressure switches, wall switches for an exhaust fan control circuit, etc.; the materials shall be supplied as defined in the relevant Section of these Specifications. For example, Section 23 0523 specifies valve requirements, and Division 26 specifies electrical products and requirements.
4. Coordinate with other trades where installation of a particular component requires other trades to be involved. Installation coordination includes location the correct placement of thermowells, flow switches, dampers, control valves, control power circuits, etc. Care must be exercised to identify locations that meet the requirements of the manufacturer including upstream and downstream distances, pressures, temperatures, etc.

3.2 PRIMARY OPERATORS STATIONS

A. The new primary operator workstation[s] hardware and software shall be installed at a location coordinated with the Owner or as indicated on the Drawings.

B. User Access

1. The Owner shall be interviewed and all desired passwords and password levels shall be installed at all workstations.

C. Reports

1. The Owner shall be interviewed and all reports desired shall be completely configured including correct formatting, delivery frequency, etc.

D. Dynamic Color Graphic Displays

1. All color graphic slides shall be developed to the satisfaction of the Owner. The slides shall include all realtime point assignments, user interactive points, and realtime alarm information. At a minimum, the following graphic slides shall be developed:

a. A graphic shall be provided for each temperature zone of each floor. This graphic shall be a "Zoom" view of the selected temperature zone of the respective floor plan. All information displayed on the building floor plan relative to any particular temperature zone and all color coding of the temperature zone shall be the same as was provided for the floor plan graphics. "Pick" windows shall be provide on these graphics to permit the operator to view specific mechanical system graphics relative to the respective floor plan.
b. Separate graphics shall be provided for all mechanical equipment serving the respective building or zone. This includes all central station units, boiler plant, air compressors, central plant, etc. Mechanical system graphics shall be displayed complete with all real time data relevant to the equipment being displayed including temperatures, flow rates, positions, etc.

2. Database Save/Restore/Backup

a. After all FMS controller software, operator workstation software, and graphic slides have been developed, two (2) complete backup sets of this software shall be delivered to the Architect for archiving.

3.3 FMS CONTROLLERS

A. General

1. All FMS controllers shall be installed in accordance with manufacturer's instructions. Power shall be provided to each FMS controller in accordance with Division 26 and all applicable codes.
2. All FMS controllers shall be installed in an enclosure that provides protection from the environment and is adequately ventilated to protect against excessive temperature exposure.

B. Input/Output

1. All points shown on the control diagrams or required to meet the Sequence of Operation shall be connected to the respective FMS controller in accordance with the manufacturer’s instructions. Each point shall be checked for voltage, short circuit, etc., prior to termination to the FMS controller to prevent potential damage to the controller.

C. Software Requirements

1. General

a. All sequences of operation listed on the Drawings are to be implemented as they relate to the points shown on the Drawings. Any additional points required to meet the sequence of operation shall be provided whether indicated on the Drawings or not. In addition to the sequences of operation indicated on the Drawings, the following general sequences shall be implemented.

2. Optimal Start

a. Develop software to start all equipment based on the individual zone temperature,

outside air temperature, heating/cooling capacity in degree Fahrenheit/hour of the equipment serving that zone and the previous optimal start time in establishing the optimal start time for the following day. The optimal start program shall work in conjunction with the scheduled start time to minimize energy consumption.

b. In no case shall the optimal start routine keep the AHU from running after the occupancy start time identified as the scheduled start time.

c. The AHUs shall run continuously until the scheduled stop time. No optimal stop program time shall be provided.

3. Run Time Totalization

a. All digital input and output points shall be setup to accumulate run time information. Maximum run time limits shall be defined and shall automatically issue a printed message as defined by the Owner.

4. Alarms

a. All analog input points shall have upper and lower limits established and alarms shall be generated in the event these limits are exceeded. The Contractor shall define reasonable limits for these alarm points. Digital inputs shall be compared to the associated digital outputs (fan start/stop and status) and alarms shall be issued if the commanded position is inconsistent with the actual condition, after a start delay timer. All alarms shall be directed to the primary operator workstations and shall be archived on the hard drives.

5. Minimum Runtimes

a. All digital output points shall have a minimum runtime of five (5) minutes to prevent accidental short cycling.

6. Staggered Starts

a. All digital outputs shall have staggered start times of at least 30 seconds to minimize demand spikes.

7. Trend Analysis (DDC Controller and all attached TCUs and ASCs)

a. In order to verify and document satisfactory system operation, at a minimum, all trend logs defined in Appendix A shall be developed and implemented. As work of this Section, all control loops, inter-start delays, minimum and maximum run times, etc., shall be tuned to meet the constraints listed in Appendix A.

b. All analog and digital trend logs shall be printed in text form with a graph of the corresponding trend data attached as the cover to the text trend data.

c. All trend graphs shall be printed, maximized in landscape form, on one 8.5" x 11" sheet of paper. Graphs requiring the display of more points than can be reasonable displayed on one graph may be graphed on separate sheet, however, the time stamps of each graph must match exactly so that data from multiple graphs may be compared.

d. Each analog graph shall include an "x" time/date axis scale and one or two "y" axis scales as required to adequately display the trend data. Each digital trend may be of any style and developed such that overlapping digital sequences are obvious to

the viewer. Each axis shall be labeled and scaled. Axis scaling shall be set to clearly show the desired control response and required trend duration. A legend shall be provided clearly defining each trend line. Graphs may be color or black and white, however, black and white graphs must use patterns making the information clearly understandable. The time and date of displayed data shall be provided on both the text trend log printout and the graph printout. Examples of the minimum level of detail that will be required for all trend graphs are included in Appendix B of this Section.

e. If trend logs are printed and graphed using cryptic systems point names, a legend shall be provided with each trend to make the translation of the trended points easily understood.

f. All required trends, graphs, and completed point verification forms shall be compiled into a project closeout notebook(s) with tabs indicating the system being trended. For example, point verification forms for AHU-1, the supply air temperature control loop for AHU-1, the static pressure control loop for AHU-1, and the mixed air temperature control loop for AHU-1 shall be included under a tab labeled AHU-1. Zone trend data may be grouped under logical headings by AHU, floor, etc. A complete detailed index of all trend data and graphs shall be included in the front of the notebook(s). A page shall also be included in the front of the notebook identifying who performed which trend log.

g. The completed closeout notebook(s) shall be provided as part of the close out documentation required in Section 23 0500. Acceptance of the system will not be given until this requirement is met.

3.4 APPLICATION SPECIFIC CONTROLLERS

A. General

1. A maximum of one ASC shall be installed on each piece of equipment (i.e., blower coil unit, air handling unit, makeup unit, etc.,) and a maximum of one piece of equipment shall be connected to one ASC.
2. Power shall be provided to each ASC and installed in accordance with Division 26 and all applicable codes.
3. All FMS controllers shall be installed in an enclosure that provides protection from the environment and is adequately ventilated to protect against excessive temperature exposure.

B. Input/Output

1. All points listed on the Drawings or required to meet the sequence of operations shall be connected to the respective ASC in accordance with the manufacturer's instructions. Each point shall be checked for voltage, short circuit, etc., prior to termination to the FMS controller to prevent potential damage to the controller.

3.5 TERMINAL UNIT CONTROLLER

A. General

1. A maximum of one (1) TUC shall be installed on each piece of equipment (i.e., fan coil,

VAV box, etc.,) and a maximum of one piece of equipment shall be connected to one (1) TUC.

2. Power shall be provided to each TUC and installed in accordance with Division 26 and all applicable codes.
3. All FMS controllers shall be installed in an enclosure that provides protection from the environment and is adequately ventilated to protect against excessive temperature exposure.

B. Input/Output

1. All points listed on the Drawings or required to meet the sequence of operations shall be connected to the respective TUC in accordance with the manufacturer's instructions. Each point shall be checked for voltage, short circuit, etc., prior to termination to the FMS controller to prevent potential damage to the controller.

3.6 OPERATOR INTERFACE PANELS

A. The operator interface panel shall be installed on or near the FMS control panel or as indicated on the Drawings. The panel shall be connected to the FMS network and programmed to allow the functionality described in Section 2.6 of this Specification.

B. The Owner shall be interviewed and all desired passwords and password levels shall be installed at the interface panel.

3.7 NETWORKING/COMMUNICATIONS

A. General

1. All LANs shall be installed in a manner recommended by the manufacturer, owner's representatives, based on the environment, communications speed requirements, and distance. All LAN media shall be installed in a manner that provides protection from physical damage and interference from RF or other electrical sources.

B. Primary Local Area Network (LAN)

1. The primary LAN shall be installed in accordance with all Division 26 communication specification requirements. The Contractor shall provide all conduit, wire, routers, hubs, etc., unless otherwise stated on the Drawings for a complete and operating FMS ETHERNET® communication network. All operator workstations and FMS controllers/routers shall be connected to the LAN.

C. FMS Controller Local Area Network (LAN)

1. The controller LAN shall be installed with materials and procedures that comply with the requirements of the FMS equipment manufacturer. In general, the conductors are to be a 22 gage, low capacitance, and twisted pair. All FMS controllers (if not connected to the primary LAN) and ACS controllers shall be connected to the LAN.

D. Sub-Controller Local Area Network (LAN)

1. The sub-controller LAN shall be installed with materials and procedures that comply with the requirements of the FMS equipment manufacturer. In general, the conductors are to be a 22 gage, low capacitance, twisted pair. All TU controllers shall be connected to the LAN.

3.8 DUCT STATIC PRESSURE STATION

A. Ensure that the direction of flow is observed when installing the probe to prevent measurement of total pressure. The connection between the duct and the flange shall be gasketed and secured with sheet metal screws to prevent any air leakage. Connections from the "HI" pressure port to the differential pressure transducer shall be 1/4" plastic tubing which shall not extend for more than ten feet. Pressure stations shall be installed 2/3 the distance down the duct of all major branch ducts or as indicated on the Drawings.

3.9 OUTSIDE AIR STATIC PRESSURE PROBE

A. Outside air static pressure probe must be installed and piped according to manufacturer's instructions to ensure accuracy of the static pressure reading and eliminate the effects of condensation in the sensing lines. Coordinate installation of probe with the necessary trades for proper sealing of all roof penetrations.

3.10 ELECTRONIC DIFFERENTIAL PRESSURE TRANSMITTER

A. All differential pressure transmitters shall be installed within ten feet of the pressure sensing point. The transmitters shall be installed in a NEMA I housing for interior conditioned spaces and in NEMA 3R housings for outside or unconditioned spaces. The transmitters and housings shall be rigidly supported to prevent vibration and shall never be mounted to ductwork or piping. Access to the transmitter shall be provided.

3.11 ELECTRONIC TEMPERATURE ELEMENT AND TRANSMITTER

A. Space temperature transmitters shall be installed 44" A.F.F. to the center of transmitter unless otherwise noted on the architectural drawings or specifications.

B. All temperature sensors installed in liquid lines, tanks, etc., shall be installed in stainless steel thermowells. The thermowells shall be supplied to the mechanical contractor for installation under other Sections of the Specification. A thermo-conductive paste shall be applied between the sensing element and the thermowell.

C. Outdoor air temperature elements shall be installed in a location that is continuously shaded and not effected by heat generating equipment or equipment intakes or discharges. The element shall be installed under a sun shield and high enough to avoid damage from vandalism.

D. Duct point temperature elements shall be installed directly on ductwork and the connection between the duct and the flange shall be gasketed and secured with sheet metal screws to prevent any air leakage. Care must be taken to avoid direct contact between the temperature

element and any heat transfer surface such as a coil.

E. Duct averaging elements shall be installed with the same requirements as for the temperature point elements; however; the averaging elements shall be extended across the entire duct area in a zigzag pattern. Special clips shall be used to secure the elements at turns to prevent chafing of the elements. Where the elements pass through the duct, plastic tubing or similar protection shall be installed on the elements to prevent damage to the elements from vibration.

3.12 AIR FLOW STATION AND TRANSMITTER

A. Pitot Tube Air Flow Element and Transmitter

1. Ensure that the direction of flow is observed when installing the station in the ductwork. The station shall be installed in accordance with manufacturer's published up- and down-stream duct length requirements.
2. All connection points shall be secured. Connections from the "HI" and "LO" pressure ports to the air flow transmitter shall be 1/4-inch plastic tubing which shall not extend for more than ten feet.
3. The flow transmitter shall be wall mounted with the display at 60" A.F.F. The flow transmitter shall be completely setup to meet the actual field measurement conditions and output CFM. Provide 24 VAC power for transmitter.

B. Thermal Anemometer Air Flow Station

1. Ensure that the direction of flow is observed when installing the station in the ductwork. The station shall be installed in accordance with the manufacturer's published up- and down-stream duct length requirements. If a suitable location for the flow station cannot be achieved, the Contractor shall consult with the engineer and manufacturer with possible alternative locations.
2. All connection points shall be secured. Provide all power requirements for the unit and connect to the FMS.

3.13 CURRENT TRANSDUCERS

A. Current transducers shall be installed on one hot leg of either single or three phase and after the local disconnect. The transducers shall be located in the motor starter housing or motor control center and secured to the structure using sheet metal screws.

3.14 CURRENT SENSING SWITCH

A. Current switches shall be installed in one leg of three phase circuits and the hot leg of single phase circuits and in all cases, after the local disconnect. The switches shall be adjusted to close at approximately 10% of the attached loads full load amps.

3.15 AIR DIFFERENTIAL PRESSURE SWITCHES

A. Differential pressure switches shall be connected to pitot tube pickup probes pointing into the air stream on both sides of the process variable. Connection between the switch and the pitot tubes shall be 1/4" hard copper. The switches shall be adjusted to close at approximately 25% of the fans maximum speed or at the dirty filter pressure differential.

3.16 ELECTRIC LINE VOLTAGE THERMOSTAT

A. Where thermostats are to be mounted remotely from the controlled device, all conductors shall be installed in a metallic raceway and the thermostat shall be mounted on a junction box. Provide a locking metallic thermostat guard over the thermostat. Mount the thermostat 48" A.F.F. unless otherwise specified on plans.

3.17 ELECTRIC FLOW SWITCH

A. Flow switches shall be installed in a Thread-O-Let installed under Sections of the Specification. The paddle of the flow switch shall be selected and the spring adjustment shall be carefully set to provide good switching between flow and no flow conditions. Ensure that the flow direction of the device matches the actual flow direction.

3.18 ELECTRIC LOW LIMIT (FREEZESTAT)

A. Low limit thermostats shall be installed with the averaging element extended across the entire duct area in a zigzag pattern. Special clips shall be used to secure the element at turns to prevent chafing of the element. Where the element pass through the duct, plastic tubing or similar protection shall be installed on the element to prevent damage to the element from vibration. The thermostat setpoint shall be set as indicated and the circuit shall be tested to ensure actions as required.

3.19 LIQUID DIFFERENTIAL PRESSURE SWITCH

A. Differential pressure switches shall be connected to pressure taps installed on the piping under other Sections of the Specification. The connections shall be 1/4" hard copper complete with isolation valves on both lines. The switch shall be supported either by mounting on a wall or on a frame constructed from Unistrut. The switch setpoint and differential shall be set as necessary to provide good switching between pressure and no pressure conditions.

3.20 CONTROL RELAYS

A. Control relays shall be field or panel mounted as indicated on the Drawings. If a relay is field mounted it will be installed in a NEMA I housing.

B. Control relays shall be installed in bases and the based mounted on a DIN rail. All accessories including end clips, jumpers, etc., shall be provided. All wiring shall be labeled. Multiple conductors shall be bundled and run by classification in plastic wireways. Relays shall be

labeled as indicated in the shop drawings for ease in troubleshooting.

3.21 CONTROL TRANSFORMERS

A. Control transformers shall be field mounted using a plate to mount on the associated junction box or panel using a foot-style mounting. Locations shall be as identified on the Drawings or as determined by field requirements. A phenolic label on each transformer shall identify the power source by breaker panel and circuit. Fusing of the primary and secondary sides and sizing shall be as defined by the NEC. Provide means of local disconnect for transformer to allow removal.

3.22 ELECTRIC-PRESSURE SWITCHES

A. Switches shall be panel mounted unless otherwise indicated. Pneumatic connections within the panel may be 1/4" plastic tubing. Switches shall be identified with a phenolic label for ease in troubleshooting.

3.23 PNEUMATIC PRESSURE GAUGES

A. Pressure gauges shall be installed in all locations indicated on the Drawings. Gauges shall be oriented so that they can be easily seen and serviced.

3.24 AUTOMATIC DAMPERS

A. All automatic control dampers shall be installed under Section 23 3000.

3.25 DAMPER ACTUATORS

A. Electronic Damper Actuators

1. Damper actuators shall be mounted on the damper jack shaft or shaft extender using a V-clamp. The actuator shall then be anchored to the ductwork housing the damper. All power requirements for the actuators shall be supplied under this Section of the Specification.

3.26 CONTROL VALVES

A. The valves shall be installed by the mechanical contractor under other Sections of the Specification.

3.27 CONTROL VALVE ACTUATORS

A. Electronic Valve Actuators

1. Valve actuators shall be supplied factory assembled with the respective control valve.

3.28 ELECTRIC TO PNEUMATIC (EP) TRANSDUCERS

A. Transducers shall be installed in control panels and shall be identified with a phenolic label for ease in troubleshooting. Connection of main and branch signals shall be 1/4" plastic tubing from the device to panel bulkhead fittings. An inline disposable filter shall be installed in the main air line to each transducer.

3.29 ELECTRICAL CONTROL POWER AND LOW VOLTAGE WIRING

A. Comply with all Division 26 installation requirements.

B. Install low voltage power in conduit in the following locations regardless of local building code allowances otherwise.

C. Install all low voltage wiring in conduit.

D. Conceal conduit within finished shafts, ceilings and wall as required. Install exposed conduit parallel with or at right angles to the building walls.

E. Do not install Class 2 wiring in conduit containing Class 1 wiring. Boxes and panels containing high voltage may not be used for low voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers).

F. All wire-to-device connections shall be made at terminal blocks or terminal strip. All wire-to-wire connections shall be at a terminal block, or with a crimped connector. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

G. Plug or cap all unused conduit openings and stubups. Do not use caulking compound.

H. Route all conduit to clear beams, plates, footings and structure members. Do not route conduit through column footings or grade beams.

I. Set conduits as follows:

1. Expanding silicone firestop material sealed watertight where conduit is run between floors and through walls of fireproof shaft.
2. Oakum and lead, sealed watertight penetration through outside foundation walls.

J. Cap open ends of conduits until conductors are installed.

K. Where conduit is attached to vibrating or rotating equipment, flexible metal conduit with a minimum length of 18" and maximum length of 36" shall be installed and anchored in such a manner that vibration and equipment noise will not be transmitted to the rigid conduit.

L. Where exposed to the elements or in damp or wet locations, waterproof flexible conduit shall be installed. Installation shall be as specified for flexible metal conduit.

M. Provide floor, wall, and ceiling plates for all conduits passing through walls, floors or ceilings. Use prime coated cast iron, split-ring type plates, except with polished chrome-plated finish in exposed finished spaces.

3.30 SMOKE AND FIRE DETECTORS

A. Smoke detectors and the associated wiring shall be installed in accordance with Section 23 0549.

3.31 TEMPERATURE CONTROL PANELS

A. All tubing and wiring shall be clearly labeled with Brady-type marker labels and run to numbered terminal strips or tubing manifolds these wire, tube, and terminal numbers shall be shown on all control diagrams. Wires and tubes shall be labeled at all connection points.

B. All control devices shall be labeled with engraved phenolic tags showing device number and name, model number, setpoint, range, action, etc. Panel Face indicators shall be labeled with engraved phenolic tags identifying what is shown on indicator.

C. Hard tubing shall be brought into the panel using bulkhead fittings; tubing within the panel may be plastic.

D. Electronic digital indicators shall be provided where shown on the Drawings. Indicators shall be LED or LCD loop powered type and fully compatible with the associated transmitter and matched to the range of the transmitters. Indicators shall be flush mounted on the control panel door.

E. Terminal strips shall be provided in all control panels for the termination of all field wiring. An additional 25% but not more than 50 terminal strips shall be provided for future use. Terminal strips shall be rated for no less than 300 VAC, 1/4" in width, track mounted, and a slot provided for labeling strips. All terminals shall be labeled as shown on the as-built drawing. No more than two conductors shall be terminated on a single terminal.

F. Control transformers shall be provided where shown or where required to meet the sequence of operation. Control transformers shall be provided with a phenolic label identifying the source of power.

G. Control panel front mounted pilot lights shall be provided where shown on the Drawings or electrical ladder diagrams. Lights shall have replaceable bulbs and lenses and shall incorporate a "push-to-test" feature. Voltage rating of pilot light may be full load voltage or dropped across a line resistor. In no case may the voltage to pilot lights exceed 120 VAC.

H. Control panels shall have wire ways installed to group all wiring within a panel. Panels shall be manufactured in a professional manner to the satisfaction on the Owner and Engineer.

3.32 REFRIGERANT VAPOR DETECTOR

A. The refrigerant vapor detector shall be installed indoors at a location indicated on the Drawings. Mount the unit at a height consistent with the manufacturer's instructions that provides for easy maintenance and visual observation.

3.33 CARBON DIOXIDE SENSOR

A. Duct carbon dioxide shall be installed directly on ductwork and the connection between the duct and the flange shall be gasketed and secured with sheet metal screws to prevent any air leakage. The sensing element shall be located at least ten feet downstream of any coil, humidifier, or dehumidified.

B. Space carbon dioxide sensors shall be installed at 48" A.F.F.

3.34 EQUIPMENT CONNECTIONS

A. FMS Class II field wiring for all non-control device applications shall be installed under this Section of the Specification. This includes equipment such as VFDs, chillers, boilers, packaged air handling equipment, etc., that may have point types include status or alarm monitored from an equipment supplier Class C contact or analog control signals to equipment, etc.

3.35 ELECTRONIC LIQUID DIFFERENTIAL PRESSURE TRANSMITTER

A. All liquid differential pressure transmitters shall be installed within ten feet of the pressure sensing points. The transmitter shall be rigidly supported to prevent vibration and shall never be mounted to ductwork or piping. The piping for the sensing points shall include isolation valves such that the transmitter can be removed without having to shut down the liquid system. Access to the transmitter shall be provided.

3.36 ELECTRONIC LIQUID PRESSURE TRANSMITTER

A. All liquid pressure transmitters shall be installed within ten feet of the pressure sensing ports. The transmitter shall be rigidly supported to prevent vibration if it is not directly connected to the pipe. The piping for the sensing points shall include isolation valves such that the transmitter can be removed without having to shut down the liquid system. Access to the transmitter shall be provided.

3.37 INDOOR STATIC AIR PROBE

A. Indoor static air probes shall be mounted in the ceiling in locations indicated on the Drawings or as required.

3.38 BOILER REMOTE SHUTDOWN SWITCH

A. The manually operated remote shutdown switch or circuit breaker shall be located just outside the boiler room door and marked for easy identification. It should be installed in a location, which safeguards it against tampering. If the boiler room door is on the building exterior, the switch should be located just inside the door. If there is more than one door to the boiler room, there should be a switch located at each door.

3.39 ELECTRONIC HVAC LIQUID FLOWMETER

A. The flow meter/transmitter shall be installed according to the manufacturer's recommendations and tied into the FMS system.

3.40 BTU METER

A. The BTU meter shall be installed according to the manufacturer's recommendations and tied into the FMS communication network. Factory calibration and setup shall be provided for each meter.

3.41 STEAM FLOW METER

The flow meter/transmitters shall be installed according to the manufacturer's recommendations and tied into the FMS system.

3.42 DOMESTIC WATER SUB-METER

A. The sensors and transmitters shall be installed in accordance with the manufacturer’s installation requirements. All inline meters shall be installed with isolation valves on both sides. A by-pass is not required. The contractor shall connect all outputs from the transmitters and meter to the FMS per the requirements of these specifications. The contractor shall provide all necessary transformers to provide power for all transmitters and meters.

3.43 GAS SUB-METER

A. The sensors and transmitters shall be installed in accordance with the manufacturer’s installation requirements. The contractor shall connect all outputs from the transmitters and meter to the FMS per the requirements of these specifications. The contractor shall provide all necessary transformers to provide power for all transmitters and meters.

END OF SECTION 23 0900

APPENDIX A

Verification Trend Log Development and Acceptance Requirements

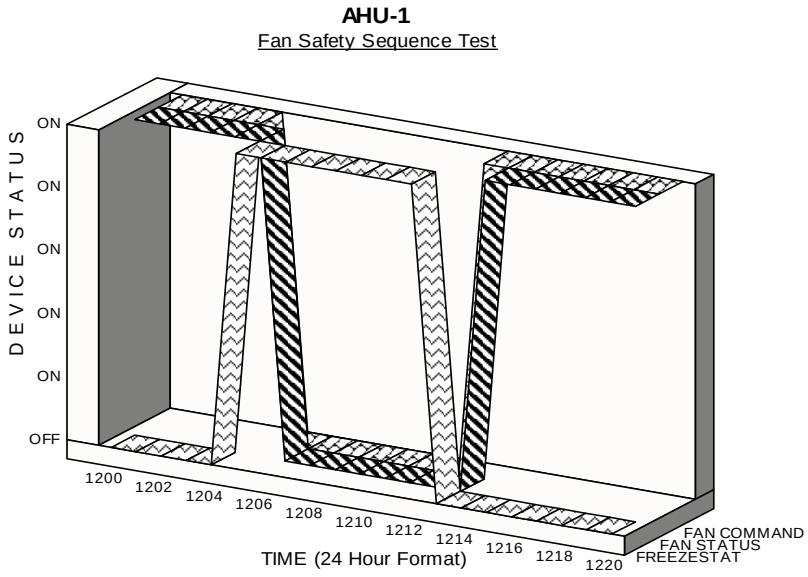
AHU-1 TREND LOG REQUIREMENTS			
Trend #1 (Supply Air Temperature Control)			
Trend Duration	Sample Interval	Trend Points	Required Response
60 minutes during occupied mode	1 minute	SA temperature SA temperature set point Chilled water valve control signal	SA temperature ±0.5°F of SA temperature SP with hunting of no more than 5% of the control signal
Trend #2 (Supply Air Static Pressure Control)			
Trend Duration	Sample Interval	Trend Points	Required Response
60 minutes during occupied mode	1 minute	SA static pressure SA static pressure set point VFD control signal	SA pressure ±0.05°F of SA static pressure SP with hunting of no more than 5% of the control signal
Trend #3 (Mixed Air Temperature Control)			
Trend Duration	Sample Interval	Trend Points	Required Response
60 minutes during occupied mode	1 minute	MA temperature MA temperature set point Mixing damper control signal	MA temperature ±0.5°F of MA temperature SP with hunting of no more than 5% of the control signal
Trend #4 (Fan Safety Test)			
Trend Duration	Sample Interval	Trend Points	Required Test Sequence
N/A - Allow 2 minutes between test sequence events	1 minute	Fan commanded position Fan (VFD) status Freezestat Condition Supply air smoke detector Return air smoke detector MA damper signal	1) Fan stopped, safeties normal; 2) Fan commanded on, safeties normal; 3) Freezestat tripped; 4) Freezestat reset; 5) SA Smoke detector tripped; 6) SA smoke detector reset; 7) RA smoke detector tripped; 8) RA smoke detector reset;

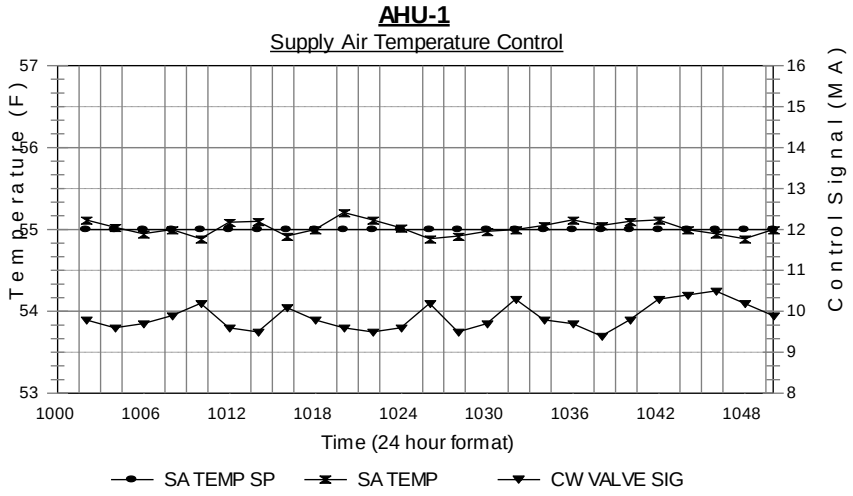
VAV TERMINAL UNIT TREND LOG REQUIREMENTS			
Trend #1 (Space Temperature Control Range Test)			
Trend Duration	Sample Interval	Trend Points	Required Test Sequence
N/A - Allow full system response recovery between test sequences	1 minute	Space temperature Space temperature set point HW valve control signal Primary air control damper signal Primary air flowrate Primary air flowrate set point Primary air flowrate maximum Primary air flowrate minimum	1) Space temperature at or near set point; 2) Adjust space temperature set point 3.0°F below actual temperature; 3) Adjust space temperature set point 3.0°F above actual temperature; 4) Return space temperature set point to design condition;
Trend #2 (Space Temperature Control)			
Trend Duration	Sample Interval	Trend Points	Required Response
24 Hours – including transitions from unoccupied to occupied and occupied to unoccupied modes	10 minute	Space temperature Space temperature set point	Space temperature remains within ±0.5°F of space temperature set point with hunting of no more than 5% of the control signal for the hot water or primary air flow rates.

SECONDARY CHILLED WATER SYSTEM TREND LOG REQUIREMENTS			
Trend #1 (Differential Pressure Control)			
Trend Duration	Sample Interval	Trend Points	Required Response
60 minutes	1 minute	CW differential pressure CW differential pressure set point Control signal to VFD #1 Control signal to VFD #2	Differential pressure remains within ±1.0 PSID
Trend #2 (Differential Pressure Setpoint Control)			
Trend Duration	Sample Interval	Trend Points	Required Response
24 Hours – including transitions from unoccupied to occupied and occupied to unoccupied modes	10 minute	CW differential pressure CW differential pressure set point Maximum position of all CW valves Minimum position of all CW valves	Set point resets so that one or more of the chilled water coil valves is between 90% and 100% open with hunting of the differential pressure set point less than 1.0 PSIG
Trend #2 (Pump Automatic Switchover Control Test)			
Trend Duration	Sample Interval	Trend Points	Required Test Sequence
N/A - Allow full system response recovery between test sequences	1 minute	CW differential pressure CW differential pressure set point CW pump #1 commanded position CW pump #1 status CW pump #1 control signal CW pump #2 commanded position CW pump #2 status CW pump #2 control signal	1) CW pump #1 on in lead position and in control; 2) Manually shut off the VFD serving CW pump #1; 3) Repeat steps #1 & #2 with CW pump #2 as the lead pump

APPENDIX B

Typical Trend Graph Requirements





APPENDIX C
Typical Point Verification Form

POINT VERIFICATION FOR AHU-1						
Point Description	Software Point Name	Point Type	Date Tested	Results (Pass/Fail)	Contractor Initials(1)	Inspector Initials(2)
SA Temp Sensor	AH1SATMP	AI	11/1/99	Pass	RTC	ALM
SA Static Press	AH1SASTAT	AI	11/1/99	Pass	RTC	ALM
Fan S/S	AH1SAFSS	DO	10/14/99	Pass	RTC	ALM
Fan Status	AH1SAFST	DI	10/14/99	Pass	RTC	ALM
Freezestat(3)	AH1FZ	DI	10/13/99	Pass	RTC	ALM
CW valve control	AH1CWV	AO	10/14/99	Pass	RTC	ALM

(1) RTC is Robert T. Conbert of Acme Control Company, Inc.
(2) ALM is Albert L. Mackey, P.E. of Zebra Commissioning Company, Inc.
(3) Freezestat is also hard wired to stop fan in the hand or auto position. These interlocks were tested on the same day.

SECTION 232313 - REFRIGERANT PIPING SYSTEM AND EQUIPMENT

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform to the applicable provisions of the General Conditions, the Supplemental General Conditions and the General Requirements.

1.2 RELATED SECTIONS

A. Section 23 0500, Common Work Requirements for HVAC.

B. Section 23 0504, Pipe and Pipe Fittings.

C. Section 23 0505, Piping Specialties.

D. Section 23 0523, Valves.

E. Section 23 0700, HVAC Insulation.

F. Section 23 0900, Facility Management System**,** for temperature control valves, meters and instrumentation.

G. Division 26, Electrical.

H. Refrigerant piping, insulation, and accessories associated with medical equipment and kitchen equipment furnished under other sections of this specification shall be furnished and installed by the equipment sub-contractors and is not a part of Division 23.

1.3 QUALIFICATION PROCEDURES

A. The storage, handling, and transportation of all refrigerants, oils, lubricants, etc. shall be accomplished in strict compliance with all State, local, and Federal Regulations including all requirements set forth by the Environmental Protection Agency (EPA) for the safe handling of regulated refrigerants and materials. The Contractor shall utilize qualified and/or certified personnel and equipment as prescribed by these requirements. In no situation shall any refrigerant be discharged to the atmosphere.

PART 2 - PRODUCTS

2.1 AIR HANDLING UNITS & FAN COIL UNITS

A. Air Handling Units & Fan Coil Units shall be as specified on the Equipment Schedule on the drawings and Section 23 7413 and 23 8126.

2.2 AIR COOLED CONDENSER

A. Furnish and install air cooled condensers located on building roof as shown on the drawings. Air cooled condenser shall be of type and capacity as specified in the Mechanical Equipment Schedule on the drawings.

2.3 PIPING

A. Refrigerant piping materials and installation shall be in accordance with the best working and piping practices for Freon refrigerants. The Contractor shall install the refrigerant piping using Type "L" hard drawn copper tubing, Federal Specification WW-T-749, with silver solder joint. All piping shall be installed in a straight manner, free from traps, and shall be provided with plugged or capped ends, as it is erected, to prevent dirt from entering. The piping system shall be provided with gauges as required for the operation of the system. The piping is shown schematically on the drawings, verify exact arrangement and pipe sizing with equipment manufacturer.

2.4 VALVES

A. Expansion valves shall be of the thermostatic type as manufactured by Alco, Sporlan, or equivalent, and shall be gas charged with capillary tube, external superheat adjustment and external equalizing connection. The expansion valves at each apparatus shall be protected by a strainer in the refrigerant liquid line to that group. The strainer shall be as manufactured by the Henry Valve Company, or equivalent, not less than line size and provided with shut-off valves before and after, and furnished with the packaged reciprocating unit.

B. Solenoid valves shall be suitable for the system in which they are used and shall be designed specifically for use with Freon refrigerants. Solenoid valves shall be furnished with the packaged reciprocating unit.

C. Refrigerant line valves shall be packless type or packed type with gas tight cap seal with wheel, globe, angle, or "T" needle type, with hard metal seats and shoulders on stems to permit packing stuffing boxes while open under pressure, or sealed diaphragm type.

2.5 DRYER

A. In each liquid line, install a suitable silica gel filter and dryer. Dryer shall be furnished with the chiller.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Piping installation shall conform to the requirements of Section 23 0500, Common Requirements for HVAC, and Section 23 0504, Pipe and Pipe Fittings.

3.2 TESTING OF REFRIGERANT PIPING SYSTEM

A. After the installation of the refrigerant piping system has been completed, all piping shall be tested and proven tight for a period of **twenty four (24)** hours at a pressure of 500 lbs. per square inch using dry nitrogen.

3.3 EVACUATION AND CHARGING

A. Upon completion of the piping pressure test, the refrigerant circuit shall be evacuated to 500 microns using a closed tube manometer and a high vacuum pump (using an electronic vacuum gauge that reads in microns) to ensure tightness of the piping and to remove air and moisture from the piping system. Upon completion of evacuation and acceptance of the system tightness, the vacuum shall be broken by the introduction of the refrigerant.

3.4 REFRIGERANT AND LUBRICATING OIL

A. Contractor shall furnish and install all of the refrigerant required to develop the system to its full rating, and in addition to the initial charge, the Contractor shall be required to provide all refrigerant required for the proper operation of the refrigeration apparatus during the first season's operation. Contractor shall guarantee that the loss of refrigerant for a season's operation shall not exceed 10% of the full charge of the system and he shall furnish any refrigerant required above this amount. This guarantee shall remain in effect until such time as the Contractor shall demonstrate this performance for one full year's operation. The Contractor shall be required to provide the initial charge of lubricating oil for all refrigeration apparatus and related equipment, and shall furnish a chart listing the type of oil and a schedule for maintenance that should be used with the various equipment.

3.5 PRESSURE RELIEF DEVICES

A. Refrigerant pressure relief devices and fusible plugs shall be installed with piping to a safe location in accordance with ANSI/ASHRAE Standard 15-1994. Discharge shall be to atmosphere at a location not less than 15 feet above the adjoining ground level and not less than 20 feet from any window, ventilation opening, or exit from any building. Discharge line sizing shall conform to ANSI/ASHRAE Standard 15-1994.

B. Each discharge pipe shall be equipped with a drip leg capable of holding 1 gallon of liquid. The drip leg shall include a manual drain valve.

END OF SECTION 23 2313

SECTION 233000 - AIR TEMPERING SYSTEM AND EQUIPMENT

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Provide all products, labor and services necessary to construct and demonstrate proper functionality of the HVAC and exhaust systems indicated on the drawings and specified herein.

B. Conform with applicable provisions of the General Conditions, the Supplemental General Conditions and General Requirements.

C. See Sections 23 0500, 23 0548, 23 0549, 23 0593, 23 0700, and 23 0900 for additional requirements.

D. Comply with the Equipment General Requirements in Spec Section 23 0500.

1.2 SCOPE

A. Install control dampers supplied under Section 23 0900. Adjust dampers for smooth operation.

1.3 SUBMITTALS

A. Submit the following for review and approval:

1. All equipment shown on the equipment schedule and elsewhere on the drawings. Submit evidence or certification that equipment complies with ASHRAE Std. 90.1.
2. Ductwork construction standards, sheet metal, plenums, ductwork accessories, etc.
3. Flues and vents: Materials of construction and accessories. For vents with horizontal offsets or expansion joints, submit layout for review.
4. Dampers for fire and smoke control: For each type of damper proposed, submit manufacturer's literature demonstrating compliance with all aspects of the specifications and drawings. Submit manufacturer's installation instructions.
5. Air Filters and Filter Gauges
6. Grilles, Registers & Diffusers: Configuration, materials of construction, finish, mounting details, and performance data including throw, static-pressure drop, and noise ratings. Submit for type only, but supplier shall check and verify that the indicated diffuser type and sizing are appropriate for each area. Advise of any concerns in any areas.
7. Terminal Units:

    a. Submit the following for each type of unit: Unit construction, materials, and wiring diagrams.
    b. Submit the following for each size unit: Dimensional data, recommended flow ranges, and performance data (pressure drop and sound data) at maximum flow.
    c. Submit a schedule showing the following for each terminal unit indicated on the drawings: Tag number, max & min CFM, size, pressure drop, and heating system performance.

8. Layouts of systems covered by this section of the specifications. Layouts shall be at a scale appropriate for the areas shown. Include large scale sections as appropriate.

1.4 QUALITY ASSURANCE

A. Comply with the following codes & standards:

1. UMC 2006 Chapter 6 – Duct Systems
2. UMC 2006 Standard 6-2, Standard for Metal Ducts
3. SMACNA 2005 HVAC Duct Construction Standards – Metal and Flexible, including Addendums
4. SMACNA Round Industrial Duct Construction Standards – 1999
5. SMACNA Rectangular Industrial Duct Construction Standards – 2004
6. NFPA-90A-2002 - Standard for the Installation of Air-Conditioning and Ventilating Systems

B. Component Characteristics

1. All components within ducts and plenums shall be non-combustible or shall have a flame spread less than 25 and smoke developed less than 50 when tested as a composite product per NFPA 255, ASTM E84, or UL 723, except where specifically permitted by the UMC and noted in the drawings or specs.

1.5 SOUND LEVELS

A. Sound levels attributable to mechanical equipment are designed to result in sound levels of NC 40 for offices, conference rooms, and NC 35 for bedrooms**,** etc., measured within the rooms. Mechanical equipment that has been substituted for the specified equipment shall perform within the specified equipment sound limitations, or will be replaced or adjusted as required. Sound levels attributable to duct vibration that result in noticeable noise or vibration to duct hangers, lighting fixtures, ceiling tees or diffusers shall be re-supported or adjusted until the disturbing noise is brought within acceptable limits.

1.6 DIMENSIONS

A. Compare all drawings and verify all dimensions both on the drawings and in the field before laying-out, cutting, and fabricating the work.

B. Refer to Section 23 0500, Common Work Requirements for HVAC, for coordination drawing requirements.

PART 2 - PRODUCTS

2.1 DUCTWORK AND PLENUMS

A. Materials: Construct all ducts, casings, plenums etc. from galvanized steel sheets except as indicated. Sheets shall be free of blisters, slivers, pits, and imperfectly galvanized spots. Reinforcing angles and bars, and duct support materials shall be same material as ductwork if exposed to the air stream, or galvanized steel if not exposed to the air stream.

1. Galvanized Steel: Per ASTM A653/A653-03 Standard Specification for Steel Sheet, Zinc-Coat (Galvanized) or Zinc-Iron Alloy-Coat (Galvanized) by the Hot Dip Process, with minimum 1.25oz/sf zinc.
2. Aluminum: Alloy 3003-H14
3. Stainless Steel: 340SS, provide No. 2B finish in exposed areas
4. Fiberglass Ductwork (Ductboard): Use only where specifically noted. Minimum 1-inch thick, 3 lb. density rigid fiberglass ductboard with glass fiber reinforced vapor barrier, UL Class 1, labeled on each board per UMC-06 Standard 6-5.

    a. Properties:
        1) Thermal conductivity for 1-inch thickness shall not exceed 0.22 Btuh/SF-F at 75 deg F
        2) Noise reduction coefficient of 0.80 on Mounting No. 6.
    b. Tape: 3-inch "Hardcast" mineral impregnated woven fiber tape with an actuator/adhesive applied in accordance with the manufacturer's directions, or thermlok heat sensitive tapes. Pressure sensitive tapes will not be accepted.
    c. Owens-Corning Fiberglass, Johns Manville, Certain-Teed or equivalent. Flexural rigidity (E.I.) average shall not be less than 475.

5. Polyvinyl Coated Galvanized Steel: Minimum 4 mil polyvinyl coating. Foremost Manufacturing Company, Southfield, Michigan. Model PCD 4 by 1 for exterior coating only, or Model PCD 4 by 4 for both interior and exterior coating.

B. Flexible Ducts: Factory fabricated, listed as a Class 1 Air Duct per UL 181 with aluminum foil interior liner, corrosion resistant helix mechanically locked to fabric to ensure dimensional stability, helix separated from air stream, R-5 fiberglass insulation, and metalized outer vapor barrier. Ducts shall be rated at 10-inch positive pressure, 5-inch negative pressure, 0.1 perm per ASTM E96, and -20 to +250^{o}F. Flexmaster Type 3M, Thermaflex M-KC, OAE.

C. Ductwork Accessories

1. Sealers: Water based, for use on galvanized steel and with the other materials specified herein, suitable for use at -20 to +200^{o}F and duct pressures to 10 inches wg, dry to the touch within 12 hours, sufficiently flexible to pass a 0.25-inch mandrel test, listed per UL-181A & 181B, and suitable for storage and application at 40–110^{o}F. Approved Manufacturers: Carlisle Coatings & Waterproofing “Hardcast,” Foster, RCD, AM Conservation Group, OAE.
2. Tapes: 4” woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal. Water, mold, and mildew resistant for indoor and outdoor service. Sealant shall be modified styrene acrylic.

2.2 SHEET METAL ACCESSORIES

A. Dampers: Factory fabricated, suitable for use with air at -20 to +240°F, galvanized steel housing and blades except as noted, rated for indicated pressures in either direction and performance rated per AMCA-500.

1. Shafts: Square or hexagonal steel, 3/8-inch or 1/2-inch, continuous through damper, mechanically fastened to damper blade, and extending through frame as required for actuator or standoff bracket and locking quadrant as required by table below.
2. Bearings: Provide for each side of each shaft, molded synthetic or stainless steel sleeve type.
3. Multi-blade dampers: Except as indicated, provide parallel-blade for 2-position applications and opposed blade for modulating applications. Provide jackshafts as required to drive large dampers.
4. Air pressure drop shall not exceed:

   a. Dampers rated at 1500 FPM: ____ in wg at 1500 FPM
   b. Dampers rated at 4000 FPM: ___ in. wg at 4000 FPM

5. The dampers described in this section are assigned Type Numbers D1 through D23. The following table summarizes key characteristics of each type of damper. Drawings and Part 3 – Execution, indicate which type of damper to use in each application.

Type	Shape	Blade	Max Size (inches)	Multiple Sections	Rated Velocity (FPM)	Rated Shutoff Press. (in. wg)	Seals	Leakage (CFM/SF @ 1 in. DP)	Notes	Ruskin Model
D1	Rect	Flat	36 x 12	No	1500	2.5	No	--	1	MD15
D1	Rect	3V	48 x 48	No	1500	2.5	No	--	1	MD15
D2	Rect	Flat	36 x 12	No	1500	2	No	--	1	MD25
D3	Rect	3V	48 x 48	Yes	1500	2	No	80	1	MD35
D4	Rect	3V	48 x 72	Yes	1500	2.5	No	40		CD35
D5	Rect	3V	48 x 72	Yes	1500	2.5	Yes	4		CD36
D6	Rect	Airfoil	60 x 72	Yes	4000	6	Yes	2	2	CD50
D7	Rect	Airfoil	60 x 72	Yes	4000	6	Yes	2		CD60
D20	Round	Flat	20	No	1500	2	No	40	1	MDSR25
D21	Round	Double	40	No	4000	10	Yes	4		CDR25
D22	Round	Double	24	No	4000	6	Yes	6		CDSR25
D23	Oval	Double	72 x 24	No	4000	10	Yes	4		CDO25

Note 1: Provide locking hand quadrant and 2-inch standoff bracket
Note 2: Aluminum Construction

B. Flexible Connectors: Except as noted flexible connectors shall be heavy fiberglass cloth; coated to be air tight, water tight, fire retardant; suitable for temperatures of -20 to +200° F; rated for 10 in. wg positive or negative; with tensile strength minimum 450 lb/inch in the warp and 340 lb/inch in the filling. Provide flexible connectors in 3-3-3 configuration, with 3-inch galvanized steel strip along each edge and 3-inches of flexible fabric in the center.

1. Standard Applications: Flame spread 20, smoke developed 40, Ventfabrics Ventglas OAE
2. Applications Exposed to Sun and Weather: Double coated with du Pont Hyphalon, Ventfabrics Ventlon OAE.
3. Applications from 200 – 500° F: Tensile Strength 285 lb/inch in the wrap and 185 lb/inch in the filling. Ventfabrics Ventsil OAE
4. Corrosive Applications: Teflon coated, Ventfabrics Ventel OAE.

C. Duct and Plenum Access Doors: Galvanized steel, gasketed. Size as required to properly inspect and service components located within the ductwork. Ruskin, Acudoor, Ductmate, OAE.

1. Rectangular ducts up to 2-inch positive or negative SP: Minimum 22 gauge frame and door thru 12-inch size, 20 gauge door for larger sizes, double gasketed (between door and frame, and between frame and duct) with cam locks, either hinged or removable. Ruskin ADH22, ADC22, ADHW22, or ADCW22, Ventfabrics, OAE
2. Round or Rectangular Ducts to 12-inch Positive Pressure: Removable oval sandwich style with gasketed inner door, insulated outer door, and large hand knobs. Ruskin ADR and ADF.
3. Ducts to 12-inch Negative Pressure: Ruskin ADHP-3.
4. Plenum Access Doors: Factory fabricated frame and door rated to 4-inch positive or 8-inch negative pressure. Provide mill finish and neoprene seals to limit leakage to less than 0.1 CFM/inch perimeter with door closed. Doors shall open against air pressure.

    a. Frame: Extruded aluminum with 1.5-inch flange and mitered corners
    b. Door: Extruded aluminum mitered frame, double wall 24-gauge galvanized steel panel with minimum R-5 insulation isolated from the air stream, full-length piano hinge and two heavy-duty latches similar to Ventlok 310.
    c. Approved Manufacturers: Ruskin GPAD or approved equal.

D. Turning Vanes:

1. Single wall: Per SMACNA HVAC Duct Construction Standards Figure 2-3 & 2-4.
2. Double wall: Airfoil shape with smoothly rounded entry nose and extended trailing edge, minimum 2” x 3” vane crossection, hot dipped galvanized steel, 26-gauge vanes, 24-gauge runner, each vane double pinned to each runner, field adjustable to required elbow aspect ratio. Performance shall not exceed the following for a 24 x 24 elbow at 2000 FPM average: Air pressure drop 0.105 in. wg; aound generated 54 dB re 10^-12 watts. Aero/Dyne Co. Model HEP, Airsan, Elgen, or equivalent.

E. Roof Curbs and Equipment Support Rails: Factory fabricated, minimum 12-inch high, galvanized steel, configured to account for roof pitch where pitch exceeds 1/4-inch/ft or where required by manufacturer of supported equipment. Coordinate with roofer and provide cant and step if needed to match roof construction.

1. Roof Curbs: 1.5-inch fiberglass insulation with nominal 2" x 2" wood nailer. Provide damper tray where a damper is indicated. Thycurb TC, Greenheck, OAE.
2. Equipment Support Rails: Nominal 2" x 4" wood nailer. Thycurb TEMS, Greenheck OAE

F. Louvers: 4-inch extruded 6063-T5 aluminum alloy frame and blades with flange, mill finish, and 1/2-inch galvanized steel bird screen.

1. Structural: Designed and furnished to carry wind load of not less than 20 psf. Intermediate mullions and supports if provided as part of louver, shall not be visible from the exterior.
2. Air Pressure Drop: Less than 0.20 in wg at 1000 FPM over free area (8.58 square feet), intake or exhaust per AMCA 500 based on 48 x 48 test sample.
3. Moisture Penetration: Less than 0.01 oz/sf over 15 minute test per AMCA-500 at 873 FPM intake over free area based on 48 x 48 test sample.
4. Ruskin ELF375DX OAE.

G. Acoustic Louvers

1. Ruskin ACL 1245, 12 inches deep, with 45 degree blade angle, 22 percent free area (48" x 48" typical unit with .15 inch w.g. maximum pressure drop, at 4277 cfm air flow). Frame and blade material shall be galvanized steel. Free field noise reduction shall be:

Band Frequency (Hz)	63	125	250	500	1000	2000	4000	8000
Reduction (db)	14	13	15	20	23	22	20	20

2. Provide bird-screen, steel channel frame, Ruskatherm blanket insulation, and perforated steel interior surface that covers insulation.

H. Thermometers: As specified in Section 23 0505.

I. Barometric Pressure Balance Dampers: Air Balance, Inc. units with adjustable counter weight, aluminum air foil design blades, nylon bearings. Match frame assembly to wall or duct.

2.3 FLUES AND VENTS FOR FUEL-FIRED EQUIPMENT

A. General: Factory-built metallic vent system, UL Listed components. Each component shall bear indication of its UL listing.

1. Heat Resistant Paint: Glidden, Metallite OAE.
2. Approved Vent Manufacturers: Metal Fab, Metalbestos, Schebler, Ampco, OAE.

B. Type B Vent: Listed per UL 441 for use with UL Listed Category I (gas or propane fired, negative pressure, non-condensing) appliances to 530° F, round or flat oval as indicated, double wall with aluminum alloy inner wall, galvanized steel outer wall, both walls hemmed to eliminate sharp edges, minimum 1/4-inch air space for sizes 6-inches and smaller and minimum 1/2-inch air space for sizes 7-inches and larger, with guides to maintain air space. Provide UL Listed vent cap. Metal Fab Type M.

1. Barometric Draft Regulator: UL Listed, double acting type.

C. Type III Vent: For use with Category III appliances or other positive pressure, non-condensing appliances including oil-fired or solid-fuel equipment not exceeding 1200° F exhaust temperature. Listed per UL-103 for use with gas, liquid or solid fuels per NFPA-211 which produce gases up to 1400° F continuously and 1800°F intermittently. Double wall with spacers

to maintain alignment, rated for 10-inch clearance to combustibles, 4-inch clearance to noncombustibles, and zero clearance to fire-rated or non-combustible chase.

1. Inner Pipe: Connected with V-bands of same material as inner pipe, and sealed with silicone sealant appropriate for the exhaust gas temperature. Pressure tight to 60 inches water.
2. Outer Pipe: Seal with V-band of same material as outer pipe. Provide silicone sealant for portions exposed outdoors.
3. Expansion Joints: Bellows type.
4. Options and Accessories:

    a. Inner Wall: 304 SS.
    b. Outer Wall: Aluminized steel.
    c. 12-year warranty against defects in materials and workmanship

D. Type IV Vent: For use with Category II or Category IV appliances (natural gas or propane-fired, positive or negative pressure, condensing, not exceeding 550° F exhaust temperature). Listed per UL-1738, double wall with 1-inch clearance and spacers to maintain alignment.

1. Inner Pipe: AL2904C superferritic SS manufactured by Allegheny Ludlun, with welded seams, connected with V-bands, and sealed with high temperature silicone sealant. Rated at 6 inches water. Thickness: 0.015-inch through 12-inch size; 0.024-inch for 14-inch and larger sizes.
2. Outer Pipe: Seal with V-band of same material as outer pipe. Provide silicone sealant for portions exposed outdoors. Thickness: 0.018-inch through 12-inch size; 0.024-inch for 14-inch and larger sizes.
3. Options and Accessories:

    a. Outer Wall: Aluminized steel**.**

4. Metal Fab Type CG

2.4 DAMPERS FOR FIRE AND SMOKE CONTROL

A. General: Factory assembled and UL listed as an assembly, suitable for horizontal or vertical air flow and for ducted or un-ducted applications. Fire dampers (FDs) shall be listed per UL 555, smoke dampers (SMDs) shall be listed per UL 555S, and fire/smoke dampers (FSDs) shall be listed per UL 555 and UL 555S. Units shall be galvanized steel except as noted. Approved manufacturers: Greenheck, Ruskin, Potorff, or approved equal.

B. Combination Fire/Smoke Dampers: Factory assembled complete with damper, actuator, thermal link, and all specified accessories, all mounted on a sleeve.

1. Construction: Round blades, rectangular parallel blades and rectangular opposed blades are acceptable, except dampers shall be rectangular opposed blade type when installed in any of the following conditions: within 10 diameters of a fan or supply register, within 3 diameters of an elbow. Internal frames in rectangular FSDs shall be low profile type for ducts 17”H and less.
2. All components factory installed and wired, including actuator, thermal link, position switches, temperature over-ride (if specified), test switch (if specified), etc. Mount all

such components on outside of FSD sleeve to the side of duct (not top or bottom) except where indicated or approved. FSDs must be suitable for rotating the unit 180-degrees so these components can be on either side of the duct.

3. Air pressure drops shall be certified per AMCA 500D. Pressure loss coefficient C_o shall not exceed the following when tested per AMCA Figure 5.3:

Size (in)	3-V Blade	Airfoil Blade	Round
12 x 12	2.41	2.01	NA
24 x 24	0.65	0.60	NA
36 x 36	0.44	0.27	NA
12 x 48	0.76	0.91	NA
12 Round	NA	NA	0.33
24 Round	NA	NA	0.23

4. Listed for installation within wall, floor or ceiling assemblies as indicated on drawings.

    a. Ratings, except as noted: 1.5-hr Fire Rated, Leakage Class 1, 350°F, 4-inch Static Pressure, Dynamic.
        1) Up to 1600 FPM: Greenheck FSD-211 (3-V blade type), OFSD-211, or FSDR-511 (round).
        2) Up to 3000 FPM: Greenheck FSD-311 or 311V (airfoil blade) or OFSD-311.
    b. 3-Hr Rated Walls: Greenheck FSD-231.
    c. Stainless Steel: Greenheck SSFSD-211 or SSFSDR-511 (round).

5. Actuators: Electric 2-position, 115/1/60 (provide factory wired transformer if required), normally closed, spring return, NEMA-1 except as noted. Actuator shall fully re-open damper when power is restored after any power interruption.
6. Accessories

    a. Transitions: Provide round-to-rectangular, oval-to-rectangular, or rectangular-to-rectangular transitions as appropriate for the application.
    b. Thermal Link: Provide re-settable bi-metallic thermal link to initiate closure when the air temperature within the duct rises to 165° F. Where indicated provide thermal links for operation at 212° F, 250° F, or 350° F. Thermal link shall be easily resettable from outside the duct.
    c. Position Switches: Provide dry contacts for remote monitoring of damper open and closed positions.
    d. Retaining plates and angles: Provide as required. Galvanized steel specifically designed for the particular FSD and included as part of the UL Listed assembly.
    e. Installation decals: Provide installation decals on the sleeve which give the installer clear installation instructions.
    f. Temperature Override Control: Provide controls so that the thermal link can be over-ridden and the FSD opened for smoke control, even if the air temperature exceeds the setting of the thermal link, provided the temperature does not exceed 350° F.

C. Smoke dampers: Similar to fire/smoke dampers noted above, except as follows:

1. Smoke dampers shall comply with UL 555S, but need not comply with UL 555.
2. Smoke dampers need not have a fire rating.
3. The thermal link and temperature override are not applicable.
4. Suitable for installation within a wall, floor or ceiling assemblies as indicated.

    a. Ratings, except as noted: Leakage Class 1, 350° F, 4-inch Static Pressure, Dynamic.
        1) Up to 1600 FPM: Greenheck SMD-201 (3-V blade type) or SMDR-501 (round).
        2) Up to 3000 FPM: Greenheck SMD-301, 301V (airfoil blade) or SMDR-401.
    b. 6-inch pressure rated: Similar to Greenheck SMD-401
    c. Stainless Steel: SSSMD-201 & SSSMDR-501 (round).

D. Fire Dampers: Dynamic rated, suitable for closing against 8-inch differential pressure. Curtain type with sleeve and 165°F replaceable fusible link, resettable. Provide round-to-rectangular, oval-to-rectangular, or rectangular-to-rectangular transitions as appropriate.

1. 1.5-hr rated: Greenheck DFD-155
2. 3-hr Rated: Greenheck DFD-355.
3. Provide 212° F fusible links for high temperature applications.

E. Ceiling Radiation Dampers: UL Classified for use with fire rated floor/ceiling assemblies, with 165°F fusible link replaceable through the damper assembly, 1.5-hr rated except as noted. Greenheck CRD-1, CRD-2 (round), CRD-60, or CRD-60X. Provide 212° F fusible link and 3-hr rated dampers where indicated.

2.5 FILTERS AND FILTER GAUGES

A. Rated per ASHRAE Std. 52.1; Class 1 or 2 per UL Std. 900; glass fiber media; suitable for operation from -20° F to +170° F; corrosion resistant; suitable for installation with pleats either horizontal or vertical, and for air flow horizontal, vertical upflow, or vertical downflow; suitable for face velocity up to 625 FPM. Unless specified elsewhere, pre-filters shall be MERV-7, and final filters (where specified) shall be MERV-14. AAF, Camfil Farr, or approved equal.

		MERV RATING						
		7	11	14	11	14	11	14
Description							High Capacity	
Configuration		2-inch or 4-inch	12-inch Cartridge		6-inch Cartridge		12-inch Cartridge	
Initial Resistance	in. wg.	0.26	0.25	0.58	0.39	0.58	0.29	0.49
Rated Velocity	FPM	500	500	500	500	500	500	500
Max Velocity	FPM	625	625	625	625	625	750	750
Recommended Final Resistance	in. wg.	0.7	1.5	1.5	1.5	1.5	1.5	1.5
Gross Media per 24 x 24 Filter	SF	14 Pleats per foot	62	62	105	125	175	175

Housing		Cardboard	Polystyrene or Aluminized Steel	Polystyrene or Aluminized Steel	Polystyrene or Aluminized Steel			
Frame		Channel	Gasketed		Gasketed		Gasketed	
AAF Model		Perfect Pleat	VariCel RF		VariCel M-Pak		VariCel V	
Camfil Farr Model		3030	RigaFlow					

B. Filter Gauges: Provide a filter gauge for each bank of filters. Gauges shall be magnehelic type with static pressure tips and inter-connecting piping. Ranges shall be 0-1 inch w.g. for all filters except bag filters which shall have a range of 0-2 inches w.g.

2.6 GRILLES, REGISTERS AND DIFFUSERS

A. General: Performance rated per ASHRAE Std 70, *Method of Testing for Rating the Performance of Air Outlets and Inlets*, steel with baked white enamel finish except as noted, for installation on a fixed surface or a lay-in T-bar ceiling as indicated on architectural drawings, rigidly constructed, vibration free, with inlet collar of sufficient length to connect inlet ductwork, sized as shown on drawings. Where frames are provided for installation in fixed surfaces, frames shall be approximately 1-1/8" wide. Sound performance rated per ADC and based on room absorption of 10dBre10^{-12} Watts and one diffuser.

1. Approved Manufacturers: Price, Krueger, Titus, Anemostat, OAE

B. Types as follows. See also the Grille and Diffuser Schedule on drawings.

1. Square Ceiling Diffusers: Louvered type, 4-way pattern, 1-piece smooth aerodynamic surfaces with no corner joints, three louvers for 12-inch sizes, four louvers for 24-inch sizes, removable louver assembly, round neck, to provide stable, horizontal air flow without dumping down to 75 FPM inlet velocity for ceiling applications, and down to 20% of maximum air flow for non-ceiling applications. Price SCD.
2. Round Ceiling Diffusers: Louvered type, 360-degree distribution, four separate 1-piece smooth aerodynamic louvers, adjustable air flow pattern (horizontal vs. vertical), round neck. Price RCD.
3. Ceiling Return, Exhaust and Transfer Grilles: 1/2" x 1/2" x 1/2" egg crate type, steel frame for surface mounting or T-bar ceiling per application, aluminum grid. Price Series 80.
4. Ceiling Rectangular Directional Diffusers: Louvered type, directional pattern as indicated on drawings, with removable louver assembly. Price SMD.
5. Sidewall Supply Registers: Double deflection with ganged horizontal front bars, individually adjustable vertical rear bars, 3/4" bar spacing and surface mounting frame. Price 520.
6. Sidewall Return, Exhaust and Transfer Grilles: Fixed horizontal bars on 3/4" centers set at 30-45 degrees, surface mounting frame. Price 530.
7. Ceiling or Sidewall Linear Supply Diffusers: Extruded aluminum with baked white enamel finish, frame suitable for lay-in or surface mounting as per the architectural drawings, all aluminum construction, flat black interior surfaces, air flow deflection vanes to provide each slot with individually and fully adjustable 180^{o} air pattern from horizontal to vertical or in between, self-aligning devices to ensure proper alignment where multiple sections are required, and corner pieces as necessary for a continuous

appearance. Provide galvanized steel side inlet plenum matched to diffuser, with plenum extension if necessary to match adjacent construction. Performance data is based on 3/4-inch slots unless otherwise indicated. See plans for required air flow, diffuser length, and number of slots. Price SDS with SDA or SDB plenum, Krueger 1910, or equivalent.

8. Ceiling or Sidewall Linear Return Registers: As specified for sidewall linear supply diffuser except without air flow deflection vanes. Price SDS.
9. Stainless Steel Sidewall Return/Exhaust Registers: Fixed horizontal blades at 1/2" spacing and 45° deflection, flange for surface mounting, and SS 90° quick-release fasteners to mount grille to frame. Provide mill finish for blades and No. 4 finish for flanges. Price Model 735H.
10. Stainless Steel Slot Diffuser: Consist of a 0.037", 304 stainless steel plenum with continuous welded joints and chamfered corners to facilitate cleaning. The diffuser face shall be stainless steel construction with slots and fixed pattern deflectors. Plenums shall have stainless steel inlet collars complete with removable dampers from plenum face. The removable dampers shall be opposed blade type, constructed of stainless steel. Damper shall be adjusted without removing face of diffuser. The diffuser face shall be attached by stainless steel 90° quick-release fasteners and safety cable to open easily. The diffuser face, mounting frame, face and interior surface of plenum shall have a #4 finish. Krueger Model HORDSS or equivalent.
11. Laminar Flow Diffuser: Extruded aluminum construction and plated steel to inhibit corrosion. The perforated face plate, damper deflector, interior baffles and diffuser back pan plenum assembly shall be of 0.040 aluminum. The perforated face plate shall open easily with 90° quick-release fasteners and safety cable for easy cleaning and damper adjustment. B11 Sterile White-Thermal Setting finish. Krueger Model LFD or equivalent.

2.7 FANS

A. General

1. Construction

   a. Factory fabricated fan, motor, drive and accessories, UL listed , with air flow rated per AMCA 211 and sound rated per AMCA.
   b. Fan wheel: Statically & dynamically balanced, with shaft sized so first critical speed is minimum 25% above maximum operating speed.
   c. Motor and Drive: Premium efficiency ODP motor per Spec Section 23 0500, direct drive or belt driven as indicated in schedule on drawings, bearings with 100,000 hr L-10 life.
      1) Variable Speed Applications: Provide Class F insulation.
   d. Belt Drives: Adjustable pitch sheave up to 5 Hp, fixed pitch above this Hp, cast and machined pulleys with all components sized for 150% of motor Hp.
   e. Dampers:
   f. Accessories:
      1) Roof Curb: Minimum 12-inch galvanized steel, fiberglass insulated, with wood nailer, damper tray and flange. Provide cant and step if needed for proper seal with roof.

2. See Section 23 0548 for Vibration Isolation requirements.

B. Centrifugal Roof Exhaust Fans

1. Leakproof construction.
2. Housing: Spun aluminum construction, reinforced wind band welded to one-piece curb cap with mounting holes on the side and integral spun venturi, spun aluminum motor compartment with readily removable cover and breather tube. All other structural components shall be galvanized steel.
3. Fan wheel: Backward inclined, centrifugal, non-overloading.
4. Motor and Drive: Motor out of the air stream, cooled with ambient air. Motor, drive and fan wheel resiliently mounted on neoprene isolators.
5. Electrical: Disconnect NEMA-1 if protected from the weather, or NEMA-3R if exposed to the weather, wired to motor, with all wiring and components per NEC and either UL Listed or UL recognized.
6. Accessories: Stamped aluminum nameplate, hinge kit to allow tilting fan up to inspect wheel, retaining chains, conduit chase and roof curb.
7. Approved Manufacturers: Greenheck Type, G, GB, CUE or CUBE as indicated. Cook, ACME, OAE.

C. Laboratory Exhaust Fan

1. General: Factory fabricated, weatherproof for rooftop installation, with inlet plenum, fan assembly, bypass damper and discharge assembly, listed per UL 705.

    a. Heavy gauge welded steel, powder costed, chemical and UV resistant, designed for wind speeds up to 125 MPH without guy wires,
    b. Intake Plenum: With bypass dampers (low leakage airfoil type, corrosion resistant, similar to Greenheck), intake hood with bird screen, access panel, and roof curb.
    c. All driveline components (motor, belt, drive, bearings, etc) located outside the contaminated air stream, and replaceable without exposure to the contaminated air stream. Belts & drives sized for 200% of motor HP, bearings sized for 200,000 hr L-10 life, shaft seal, AMCA Class B or C spark resistant construction,

2. Mixed Flow Fan Style: Mixed flow fan with fan, motor and drive resliently mounted on neoprene-in-shear isolators.
3. Centrifugal Fan Style: Backward inclined fan, housing with access door, fan and motor mounted on rigid steel frame, spring isolators with minimum 1-inch static deflection, and fabric inlet flexible connector.
4. Accessories: Color as selected by architect from among manufacturer's standard colors, windband acoustic attenuator, double wall plenum, isolation damper, roof curb, and factory wired electrical disconnect.
5. Approved Manufacturers: Greenheck Model MD or CD, Strobic Air, OAE.

2.8 COILS

A. Galvanized steel casing, copper tubes and aluminum fins except as noted, with tubes mechanically expanded into fins, circuited to allow completely draining and venting coil, drain and vent connections, with performance rated per ARI Do not exceed scheduled air or water pressure drops by more than 5 percent.

2.9 AIR HANDLING AND AIR CONDITIONING UNITS

A. General

1. Acoustical performance shall be established per ARI 260 rating procedures. Measurements will be taken in an ANSI 12.32 qualified room using a calibrated reference source per ARI 250. Sound data supplied shall meet or be less than requirements established later in this Specification. (Data presented in dBA, sones, Bels is not acceptable.)

PART 3 - EXECUTION

3.1 DUCTWORK AND PLENUMS

A. Ductwork

1. Construct ductwork with wall thicknesses and reinforcing per the SMACNA HVAC Duct Construction Standards, Second Edition, 1995, and UMC 2006 Chapter 6,
2. Pressure Classes: Construct ductwork to the following pressure classes:

Duct Element Description	Relative Pressure	Pressure Class
From Outside Air Louver to Filter:	N	1"
From Air Handling Unit to Terminal Unit:	P	4"
From Single Zone AHU to Diffuser	P	2”
From Terminal Unit to Diffuser:	P	1"
From Return Grille to Fan:	N	1"
From Return Fan to Relief Louver:	P	1"
From Exhaust Register to Exhaust Fan:	N	2"

3. Minimum thickness for sheet metal ductwork: 26 gauge.
4. Sealing: Seal ductwork and plenums as follows:

	----------Seal Class----------			
	-----Supply Ducts----			
Location	≤2 in. wg	≥2 in wg	Exhaust	Return
Outdoors	A	A	C	A
Unconditioned Spaces	B	A	C	B
Conditioned Spaces including RA Plenums	C	B	B	C

Seal Class	Description
A	All transverse joint, longitudinal seams and duct wall penetrations.
B	All transverse joints and longitudinal seams.
C	Transverse joints

a. Apply duct sealer to inside of seams and joints. Do not use pressure sensitive tape as the primary sealant.

5. Clearance to earth: Maintain minimum 4-inch separation between ductwork insulation and earth.
6. Openings in Ductwork: During installation protect the open ends of ducts to prevent debris and dirt from entering.
7. Provide turning vanes in square elbows of low velocity supply and exhaust ductwork.
8. Collars: Where exposed ducts pass through walls, floors, or ceilings, provide a tight-fitting, flanged sheetmetal collar around duct and tight against finished surface to cover opening and present a neat appearance. Lock collar to duct.
9. Cross Breaking: Cross-break low velocity rectangular sheetmetal ducts on all four sides. Cross break sheet metal between standing seams or reinforcing angles. The center of cross break shall be of the required height to assure surfaces being rigid. Do not cross-break high velocity plenum panels.
10. Grilles Registers and Diffusers: Install plumb, affix to general construction as appropriate, make air-tight connection to ductwork, and adjust air flow pattern to achieve appropriate velocities in the occupied zones. Request direction from Engineer if any question exists regarding proper air flow adjustment.
11. Duct Thermometers: Provide thermometers to indicate mixed air, outside air, and supply air of indoor air handling units over 2,500 cfm and where shown on the Drawings.
12. Test Holes: Provide test holes in ducts at locations where testing is required per Section 23 0593 and as requested by the T&B agent. Close test holes with rubber plugs. Reseal all insulated ductwork with the same insulation, jacket and vapor barrier material after T&B is complete.
13. Closure Systems:

    a. Rigid Air Ducts: Comply with UL 181A – Standard for Closure Systems for Use with Rigid Air Ducts and Air Connectors.
    b. Flexible Air Ducts: Comply with UL 181B – Standard for Closure Systems for Use with Flexible Air Ducts and Air Connectors.

14. Factory Made Air Ducts: Install in accordance with the terms of their listing and the manufacturer's recommendations.
15. Acoustic Insulation: See Section 23 0700, HVAC Insulation. Fabricate ductwork so the dimensions indicated on the drawings are the clear dimensions for air flow inside the acoustic insulation.
16. Coordination with Building Construction

    a. General: The drawings show the general intended configuration of the ductwork. Provide additional offsets where necessary to coordinate with the building construction or with the work of other disciplines. Transition ductwork as required at no change in contract price. Where this is necessary, submit for review and maintain the indicated flow areas.
    b. Ductwork is frequently routed through bar joists and between bar joists. Coordinate duct locations with joist submittals prior to fabrication.

B. Special Applications

1. Moisture Laden Ductwork: Stainless steel with all joints liquid-tight by continuous external welding. Welds shall be free from pits, runs, spatter and other imperfections.

Pitch horizontal ductwork downward to intake opening. Where traps occur that collect water, provide a 1/2-inch half coupling welded to the bottom of the duct and pipe to spill over nearest drain. Include a properly sized trap in the drain piping.

2. Fume Hood Ductwork: Stainless steel with seams and joints continuously welded on the exterior. Spiral lock seam is not acceptable.
3. Shower Room Exhaust Ductwork: Aluminum
4. Ducts Handling Corrosive Vapors: Either stainless steel or galvanized steel with internal polyvinyl coating constructed and sealed as noted.
5. Underslab Ductwork: Galvanized steel, polyvinyl coated on the exterior, constructed and sealed for 2-inch SP, insulated per Section 23 0700, and concrete encased. Concrete thickness shall be as indicated on the drawings, but not less than 2-inch thick.

    a. Take care to prevent damaging ductwork when concrete is poured. Work with and provide guidance to the contractors responsible for pouring concrete and responsible for installing the building moisture protection system.
    b. Anchor ductwork not more than 4-ft on centers to prevent floating. Use minimum 12-gauge wire or 16-gauge straps. Protect openings in ductwork with wood or metal blocking.
    c. Pour concrete in maximum 12-inch lifts with each layer being allowed to set before pouring the next. Do not use power vibrators shall not be used in placement of concrete on or around ducts.

6. Fiberglass Ductwork (Ductboard)

    a. Provide fiberglass ductboard only where specifically indicated on the drawings and in this specification.
    b. Install per UMC-06 Standard 6-05 – Standard for Installation of Factory-Made Air Ducts and SMACNA Standard 1884-2003 – Fibrous Glass Duct Construction Standard.
    c. The drawings indicate required clear inside dimensions for air flow.
    d. Where a duct constructed of ductboard penetrates a wall or floor which requires a fire damper, smoke damper, or fire/smoke damper, install the FD, SMD or FSD in the wall per its listing, make sheet metal connections to the damper if required, and then transition back to ductboard.

7. Exterior Ductwork: Install ductwork as specified herein and insulate per Section 23 0700. Then enclose the exposed top and sides of ductwork with 28 gauge galvanized steel or 26-guage aluminum to protect the insulation. Repair any damage to the insulation jacket. Slope sheet metal enclosure to shed water.

C. Hangers and Supports

1. Securely support ducts per SMACNA and UMC Table 6-7. Provide support at each concentrated load and at each change in direction. Provide supports on each side of rectangular ducts and equipment. Where vertical ducts pass through floors or roofs, support with angles or other steel members attached to minimum two opposite sides of duct. Size supports to rigidly support the ductwork. Provide lateral support.
2. Hangers for terminal units: Minimum four 1" x 1/8" galvanized steel straps or two angle trapeze supports.
3. Horizontal Round Ducts: 30 inches and larger in diameter: Provide 2" x 2" x 1/8" black steel rolled angle ring on 6-ft centers, and support from angle.

D. Plenums

1. Single Wall Plenums: Shop fabricated minimum 16 gauge galvanized sheet steel. Horizontal and vertical panels are to be fabricated of 2' x 10' sheets. Unless otherwise dimensioned on the Drawings, access door frames are not to exceed 16-3/4 inch width. Where door width exceeds 16-3/4 inches, vertical panels shall be fabricated around 2" x 2" x 1/4" angle. If the plenum height or width exceeds 9 feet, provide a 2-1/2" x 1/8" continuous galvanized steel strip between each horizontal and vertical seam. Provide high velocity cement at each joint during panel assembly. Panels are to be bolted as shown on the details or tack welded at the Contractor's option; however, enough panels must be bolted to allow removal of equipment from the plenums. Cover interior surfaces with 2-inch thick, acoustical lining.

   a. Plenum Access Doors: Minimum two fastening devices that can be operated on either side of the door; these devices to be readily operated and moving parts to have bronze pins. All parts of the door shall be constructed of galvanized iron and shall be airtight. Latches: "Ventlock" No. 310 OAE.

2. Double Wall Plenums: Factory fabricated, Semco or equivalent. Submit shop drawings for review including overall configuration, construction details, access doors, erection drawings and structural calculations stamped by a registered structural engineer,.

   a. Factory fabricated, minimum 18 gauge galvanized steel outside, perforated galvanized steel inside, with **[4-inch] [2-inch]** sound insulation between. Plenums downstream of final filters shall have solid inner panel.
   b. Heat transfer coefficient shall not exceed 0.0575 BTUH/SF-F at 75 deg F mean temperature. Pressure Ratings: 12 in. wg positive and 10 in. wg negative.
   c. Noise attenuation shall be as follows in decibels, re 10^{-12} watts.

	OCTAVE BAND							
	1	2	3	4	5	5	7	8
Attenuation, db:	26	30	36	41	34	36	44	37
Noise Absorption Coeff:	0.22	0.39	1.20	1.36	1.03	0.84	0.74	0.68

3.2 DUCTWORK ACCESSORIES

A. Dampers: Install dampers with shafts horizontal. Locate dampers so that actuators are readily accessible. Verify that dampers operate smoothly.

1. Manual Dampers (Balancing Dampers): Damper Types D1 through D23 are all suitable for use as manual balancing dampers. Provide locking quadrants.
2. Automatic Applications: The following damper types may be used for automatic applications: D4, D5, D6, D7, D21, D22 and D23. Provide damper actuators per Section 23 0900.

B. Flexible Connectors: Provide flexible connectors at locations indicated on the drawings and at the inlet and outlet of each fan directly connected to duct system. Select flexible connectors appropriate for the application. Provide steel spring vibration isolators spanning across flexible connections of isolated fan housings to prevent blow-apart due to horizontal displacement of fan housings.

C. Access Doors: Provide as required for access to all components located within ductwork. Locate to facilitate access to such components. Size as appropriate. In addition to locations specifically called out on the drawings or elsewhere in these specs, provide access doors at the following: FDs, SMDs, FSDs, instrumentation mounted within ductwork, fan bearings.

D. Turning Vanes: Provide turning vanes in square elbows of all supply ducts. Single wall turning vanes may be used in ducts up to 1500 FPM and 24-inch vane length. Provide double wall turning vanes in ducts exceeding either of these criteria.

E. Roof Curbs and Equipment Support Rails: Coordinate the location of roof curbs and rails with the roof structure, ductwork distribution, and other work. Install after roof deck is installed but before roof is insulated. Mount curbs and rails securely to deck per manufacturer's recommendations. Provide counterflashing as required.

F. Louvers: Coordinate louver size and construction with structural and architectural openings to assure proper fit. Securely fasten louver to internal structural members to withstand a force of 25 lb/sf plus a safety factor of 3.0.

G. Instrumentation: Install duct thermometers and filter gauges so they are easily readable from the operator level.

3.3 FLUES AND VENTS FOR FUEL-FIRED EQUIPMENT

A. General: Install per the drawings and these specifications, manufacturer's instructions, the terms of the vent's UL Listing, the UMC and NFPA-211.

1. Use the same type vent for the entire system from the equipment connection to the termination outside. Provide all fittings, transitions, adapters, supports, storm collars, etc.
2. Install per the venting requirements of the appliance manufacturer. Comply with clearances per UL Listing. Minimize offsets and resistance to flow. System shall develop a positive flow adequate to remove products of combustion to outside. Do not run any portion of the vent system through any supply or return air duct or plenum. Do not connect the vent from any Category I or II (non-positive pressure) appliance with any Category III or IV (positive pressure) appliance. Do not install any manually operated damper at any point in vent system.
3. Properly support the system and make provisions for thermal expansion. Install so as to prevent leakage of flue gases into the building. Provide drain connections where condensate is likely to accumulate, and pipe to spill over floor drain.
4. Provide ventilated thimbles where vents pass through walls, floors and roof. Paint all galvanized or aluminized steel parts exposed to the weather with one coat of corrosion and heat-resistant primer, and one coat of heat resistant paint.
5. Terminate low heat appliances as indicated on the drawings, but not less than:

    a. 3 ft above the highest point where the vent passes the roof.

b. 2 ft above any portion of a building within a horizontal distance of 10 ft.
c. 3 ft above any forced air inlet located within 10 ft.

B. Type B: If a draft damper is supplied with the appliance for installation in the flue, install it per manufacturer's instructions. If appliance is listed for use with a draft hood but is not supplied with one, provide a properly sized barometric draft regulator immediately in the vent outlet, and install per manufacturer's recommendations. Pitch vent up minimum 1/4-inch per foot. Join sections per manufacturer's recommendations using sheet metal screws or proprietary closure system of a UL Listed venting system. Provide vent cap,

C. Type III and IV: Install per the drawings and these specifications, per manufacturer's instructions, per the terms of the vent's UL listing, and per NFPA-211.

3.4 DAMPERS FOR FIRE AND SMOKE CONTROL

A. Select FDs, SMDs and FSDs as appropriate to the application. Dampers may be rectangular or round, and single-section or multi-section as required, but shall not be less than the duct sizes indicated on the drawings nor larger than the maximum sizes per the UL listing for a given style of damper. Provide transitions and sleeves as required.

1. FSDs may be used where SMDs are indicated provided they meet the required ratings of the indicated SMDs and provided the FSDs are installed in accordance with their listing.

B. Install dampers in accordance with their listing. Terminate acoustic lining at dampers as necessary to ensure proper damper operation. Install actuators and access doors on the side of the duct unless space conditions preclude this. Provide adequate clearance for proper operation, and minimum 36-inch clearance for servicing actuator.

1. When space conditions preclude installing actuators on the side, such components may be installed on the top or bottom of the duct provided good access to these components is maintained.
2. When size requires the use of multiple dampers, provide framing to ensure the dampers remain in place.
3. Provide a duct access door at each FD, SMD and FSD for inspection and maintenance. Provide minimum 1/2-inch high label, "SMOKE DAMPER," "FIRE DAMPER," or "FIRE/SMOKE DAMPER."

C. Test all SMDs and FSDs after the system is installed to ensure proper operation based on both smoke and fire signals. Advise Owner minimum 2 weeks in advance and invite him to observe these tests. Submit a written report with a table which identifies each such damper (along with plans which indicate each such damper); gives its size, type and model number; the date on which it was tested; the test results; and places for the initials of the person performing test for the contractor and the person witnessing test for owner. Should any dampers fail to operate properly, service them and demonstrate proper operation. Reset all dampers when the testing is complete.

3.5 FILTERS AND FILTER GAUGES

A. Provide one set of MERV-7 temporary filters until testing and balancing is complete. Then immediately before the system is turned over to the Owner at the completion of the project, remove these filters and provide the specified filters.

3.6 TERMINAL UNITS

A. Install terminal units so that controls and piping components are readily accessible for normal service and maintenance. Provide minimum 3 ft clear in front of control panels.

3.7 GRILLES REGISTERS AND DIFFUSERS

A. Install grilles, registers & diffusers (GRDs) square with building construction. Mount sidewall GRDs minimum, 3-inches above floor level. If GRDs have provisions to adjust the direction of air flow, submit a written recommendation regarding the best direction for air flows, obtain written approval from the Owner's Representative, and adjust GRDs accordingly.

B. Verify frame types with architectural RCPs prior to ordering GRDs.

3.8 CLOSEOUT ISSUES

A. Leakage Testing

1. Pressure test not less than 25% of the installed ductwork of each system rated at 3 in wg or more, either positive or negative pressure. Advise Owner's Representative when systems will be ready for testing. For large systems separate tests may be made on different sections. The Owner's representative will designate the sections to be tested, but not more than 24 hours in advance of test. Cap ends of ducts as required and provide equipment as required for testing.
2. Measure duct leakage per the SMACNA HVAC Duct Leakage Test manual. Leakage shall not exceed the following:

   $L_{max} = C_L P^{0.65}$, where
   L_{max} = maximum permitted leakage, cfm/100 sf of duct surface area
   C_L = Duct leakage class (cfm/100 sf at 1-inch wg)
   = 6 for rectangular sheet metal, rectangular fiberglass, and round flexible ducts
   = 3 for round and flat oval sheet metal or fiberglass ducts
   P = Test pressure. Test pressure shall match system pressure class.

3. If sample is defective, the contractor shall repair or modify the defective section and re-test it to demonstrate compliance. In addition, for each section which fails its original pressure test, the Owner's Representative will designate an additional ductwork section of similar size, for the Contractor to test. This section will be in addition to 25% area originally planned to be tested. .
4. Complete all leakage testing and repairs prior to concealing ducts.
5. Submit a test report that documents the test procedure and results. Include:

a. Test equipment – model numbers, technical data, calibration data, etc.
b. Drawings showing the extent of the systems tested.
c. Test results.
d. Dates, witnesses, and signatures of witnesses.

B. Testing and Balancing: Test and balance the complete air tempering system as specified in Section 23 0593. It is anticipated that the TAB effort will identify some system deficiencies. Work in a cooperative manner to identify the cause of these deficiencies. Where deficiencies aer due to defects in installation, or workmanship, repair as required and re-test to demonstrate proper performance.

C. Cleaning

1. All ducts, coils, housing, registers, grilles, fans, etc., shall be clean when installed and shall be kept clean until the system is completed. As the various parts of the system are installed, they shall be wiped or blown clean and openings taped dust-tight with heavy paper or cardboard until the system is completed and ready for testing. At that time all covers and protective wrappings shall be removed. Where one has been torn or previously removed, the duct, coil, register, etc., shall be carefully cleaned of any dirt or dust that has entered the opening.
2. Before the ceiling is installed and final connections are made to the high velocity terminal units, it will be required that the fans be operated at full capacity to blow out dirt and debris from ducts. If it is not practical to use the main supply blower for this test, the ducts may be blown out in sections by a portable fan. After the ducts have been cleaned, the final connections shall be made to the high velocity units.

END OF SECTION 23 3000

SECTION 233813 - KITCHEN EXHAUST SYSTEMS

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform to applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

B. Comply with all requirements specified in Section 23 3000, and see that section for components and installation requirements not specified in this Section.

C. See Sections 23 0500, 23 0548, 23 0549, 23 0593, 23 0700, and 23 0900 for related work.

1.2 SCOPE

A. Provide all equipment, sheetmetal, and HVAC system components indicated on the drawings and specified herein for complete and functional HVAC systems to serve the kitchen. This section includes those components that are unique to the kitchen makeup and exhaust air systems. Certain components are specified in Section 23 3000, Air Tempering System and Equipment.

B. Rough-in and connect to kitchen hoods supplied and/or installed by others.

1.3 SUBMITTALS

A. Submit the following for review and approval:

1. All equipment shown on the equipment schedule and/or specified herein.
2. Ductwork construction standards, accessories, and layouts. Layouts shall be at a scale appropriate for the areas shown, but not less than 3/8-inch = 1’-0”. Include large scale sections as appropriate.

1.4 QUALITY ASSURANCE

A. Comply with UMC-2006 Chapter 5 Articles 5.07 through 5.17.

B. Comply with NFPA-96.

C. Fire extinguishing systems shall be installed by persons trained and qualified to install the specific system provided.

1.5 DEFINITIONS

1. Type 1 Hood: A kitchen hood for collecting and removing grease and smoke.

PART 2 - PRODUCTS

2.1 EXHAUST FANS

A. Centrifugal Roof Exhaust Type:

1. Factory fabricated fan, motor, drive, and accessories specifically designed for kitchen hood exhaust applications. Leakproof construction, listed for grease removal per UL 762, with air and sound data listed per

a. Housing: Spun aluminum construction, vertical discharge, reinforced wind band welded to one-piece curb cap with mounting holes on the side and integral spun venturi, spun aluminum motor compartment with readily removable cover and breather tube. All other structural components shall be galvanized steel.
b. Fan wheel: Backward inclined, centrifugal, non-overloading, statically and dynamically balanced, with shaft sized so first critical speed is minimum 25% above maximum operating speed.
c. Motor and drive: Premium efficiency ODP motor per Spec Section 23 0500, out of the air stream, cooled with ambient air, direct drive or belt driven as indicated in schedule on drawings, bearings with 100,000 hr L-10 life. Motor, drive and fan wheel resiliently mounted on neoprene isolators.
   1) Variable Speed Applications: Provide Class F insulation.
d. Belt Drive: Adjustable pitch sheave up to 5 Hp, fixed pitch above this HP, cast and machined pulleys with all components sized for 150% of motor Hp.
e. Electrical: Disconnect (NEMA-1 if protected from the weather, or NEMA-3R if exposed to the weather) wired to motor, with all wiring and components per NEC and either UL Listed or UL recognized.
f. Accessories: Stamped aluminum nameplate, hinge kit to allow tilting fan up to inspect wheel, retaining chains, grease trap with absorbent material, drain trough which can be piped either to a roof-mounted grease collector, or can be piped back to the hood, conduit chase and roof curb.
   1) Roof Curb: Minimum 12-inch galvanized steel, fiberglass insulated, with wood nailer, and flange. Provide cant and step if needed for proper seal with roof. Provide ventilated extension curb so exhaust duct extends minimum 18-inches above roof deck, and so fan discharges minimum 40-inches above roof deck.
g. Approved Manufacturers: Greenheck CUE or CUBE, Cook, Captive Aire, or approved equal.

2.2 DUCTWORK

A. Makeup Air System: Galvanized steel per Section 23 3000.

B. Type 1 Hood Exhaust Systems

1. Ductwork and Supports: Minimum 16-gauge carbon steel or 18-gauge SS.
2. Access Panels: Minimum 16 gauge steel with latching mechanism or bolted door fasteners, grease-tight, UL Listed for installation into grease duct, with temperature resistant gasket and sealant. Acudor, Flame Guard, or equal.

3. Alternate: A UL Listed, double wall grease duct system may be used in lieu of a welded system as specified here. All fittings and joints shall be supplied by the Manufacturer. Provide all necessary cleanouts, drains, etc. Approved manufacturers: Metal Fab, Metalbestos Schebler, DAE.

2.3 KITCHEN HOOD – TYPE I – GREASE HOOD

A. Baffle Filter Canopy Hood, Wall Style, Exhaust Only with Single Wall Front

B. Provide Exhaust Hood as shown on plans and in accordance with the following specification:
1. Kitchen Ventilation hood(s) shall be of the Type I, exhaust only wall canopy suitable for all types of cooking applications. The hood(s) shall be U.L. 710 Listed without a fire damper (with optional) for 400°F, 600°F, or 700°F rated cooking appliances. Please visit www.ul.com for U.L. 710 listing for performance and size options. Make-up air shall be independently provided.
2. The hood(s) exterior shall be constructed of a minimum of 18 gauge 400 series stainless steel. The hood(s) shall be constructed using the standing seam method for optimum strength and with a Performance Enhancing Lip (PEL) to improve capture efficiency by turning air back into the hood. An integral 3 inch air space is provided to meet NFPA® 96 clearance requirements against limited combustible walls. All seams, joints and penetrations of the hood enclosure shall be welded and/or liquid tight. Lighter material gauges, alternate material types and finishes are not acceptable. All unexposed interior surfaces shall be constructed of a minimum 18 gauge corrosion resistant steel.
3. The hood(s) shall include a filter housing constructed of the same material as the hood. The filters shall be aluminum baffle type, U.L. 1046 Classified, and in sufficient number and sizes to ensure optimum performance. The filter housing shall terminate in a pitched, full length concealed grease trough which shall drain into a removable grease container. The hood shall include stainless steel backsplash panel, trim skits at ceiling and hood, and end panels for improved exhaust capture.
4. Vapor proof, U.L. Listed incandescent light fixtures shall be pre-wired to a junction box located at the top of the hood for field connection. Wiring shall conform to the requirements of the NFPA® 70.
5. The canopy hood(s) shall be factory constructed by Greenheck or approved equivalent. They shall be built in accordance with the NFPA® 96, IMC, UMC, and bear the NSF Seal of Approval. The hood manufacturer shall provide, on request, the necessary data that confirms compliance with the code authorities listed above.
6. Kitchen hoods shall include complete Ansul Fire Suppression system including all components required for fire suppression, including stainless steel utility cabinet, chemical agent, chemical piping and nozzles, additional contacts for controlling exhaust fans, makeup air shutdown, gas valve control at appliances and electrical shunt trip breaker. Refer to plans for wiring diagrams associated with this control.
7. Temperature sensors and control compliant with 2015 IMC requirements.
8. The equipment supplier shall furnish a field representative site visit, to complete fire suppression system installation and certification that system is operational and functional.

PART 3 - EXECUTION

3.1 EXHAUST FANS

A. Install roof curb as per Spec Section 23 3000, and install fan onto curb. Connect ductwork per fan manufacturer's recommendations and per UMC Section 511.

3.2 DUCTWORK

A. General:

1. Comply with the requirements specified in Section 23 3000 and UMC Sections 507 – 517.
2. Install without forming dips or traps which might collect residue
3. Lowest end of main duct shall be flush on the bottom with branch duct.

B. Exhaust Ductwork for Type I Hoods

1. Install ductwork, insulation, grease removal devices, fans, etc, so as to maintain required clearances from adjacent construction.
2. Materials and Thicknesses:

    a. Interior Ductwork: 16-gauge steel or 18-gauge SS
    b. Exterior Ductwork: 18 gauge SS

3. Construction:

    a. All seams, joints, penetrations, duct-to-hood collar connections, etc, shall be continuously welded and liquid-tight except as permitted by UMC Section 510.5.2.1.
    b. Install so that grease cannot become pocketed in any portion of ductwork.
    c. Telescoping or bell-type duct joints: Configure to be self-draining and per UMC Section 510.5.2.2.
    d. Slope: Minimum 1/4 inch per foot to drain toward hood or approved grease reservoir. Where horizontal length exceeds 75 ft, slope not less than 1 inch per ft.
    e. Bolts, screws, rivets and other mechanical fasteners: Shall not penetrate duct walls.

4. Dampers and flexible connectors: Do not provide in Type 1 hood exhaust systems.
5. UL Listed Grease Duct Systems: Install in accordance with their listing, and per manufacturer's recommendations.
6. Openings:

    a. Provide as required to allow proper operation, maintenance, inspection and cleaning of all sections of ductwork, and as required by code.
    b. Provide at each change in direction.
    c. Locate so as to provide unobstructed access to openings. Provide a sign on each access panel reading, "ACCESS PANEL – DO NOT OBSTRUCT."
    d. Provide within 3 ft of fan inlet and outlet where fans have ducted connections.
    e. Horizontal Ducts:
        1) Provide openings large enough for cleaning. Locate not more than 12 ft on

centers.

2) Where any duct crossectional dimension is 24-inches or larger, provide minimum one 20-inch x 20-inch opening for personnel entry. Provide hangers to support the weight of ductwork plus 800 lbs.
3) Install on sides or top of duct, minimum 1-1/2 inch from the bottom of the duct.

f. Vertical Ducts:
1) Where personnel entry is possible provide access door at top of riser
2) Where personnel entry is not possible, provide access door at each floor level.

7. Supports: Provide as required to support vertical and lateral loads within the stress limitations of the building code. Supports shall be of the same material as the ductwork.
8. Damage to Covering or Enclosure: Advise Owner's Representative if any portion of ductwork, insulation or ductwork enclosure is damaged in any way, and repair so as to restore fire-resistance rating.

END OF SECTION 23 3813

SECTION 237413 - PACKAGED OUTDOOR CENTRAL STATION AIR HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes packaged, outdoor, central-station air-handling unit (rooftop make-up air unit) with the following components and accessories:

1. Direct-expansion cooling.
2. Gas furnace.
3. Economizer outdoor, filter, and return-air damper section.
4. Exhaust air plenum, exhaust fan and filter.
5. Integral, space temperature controls.
6. Custom roof curbs.

1.2 DEFINITIONS

A. Outdoor-Air Refrigerant Coil: Refrigerant coil in the outdoor-air stream to reject heat during cooling operations and to absorb heat during heating operations. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.

B. Outdoor-Air Refrigerant-Coil Fan: The outdoor-air refrigerant-coil fan in RTUs. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.

C. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.

D. Supply-Air Fan: The fan providing supply-air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

E. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

1.3 SUBMITTALS

A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.

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.

C. Field quality-control test reports.

D. Operation and maintenance data.

E. Warranty.

1.4 QUALITY ASSURANCE

A. ARI Compliance:

1. Comply with ARI 210/240 and ARI 340/360 for testing and rating energy efficiencies for RTUs.
2. Comply with ARI 270 for testing and rating sound performance for RTUs.

B. ASHRAE Compliance:

1. Comply with ASHRAE 15 for refrigerant system safety.
2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
3. Comply with 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."

D. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.

E. UL Compliance: Comply with UL 1995.

F. 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 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of RTUs that fails in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
2. Warranty Period for Gas Furnace Heat Exchangers: Manufacturer's standard, but not less than 15 years from date of Substantial Completion.
3. Warranty Period for Solid-State Ignition Modules: Manufacturer's standard, but not less than three years from date of Substantial Completion.
4. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

C. Basis-of-Design Product: Subject to compliance with requirements, provide Trane or a comparable product by one of the following:

1. Carrier
2. York
3. Daikin

2.2 CASING

A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.

B. Exterior Casing Material: Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.

1. Exterior Casing Thickness: 0.0626 inch thick.

C. Inner Casing Fabrication Requirements:

1. Inside Casing: Galvanized steel, 0.028 inch, perforated 40 percent free area.
2. Exhaust plenum: Galvanized steel, 0.028 inch, perforated and factory applied acid resistance coating.

D. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

1. Materials: ASTM C 1071, Type I.
2. Thickness: 1 inch.
3. Liner materials shall have air-stream surface coated with an erosion- and temperature-resistant coating or faced with a plain or coated fibrous mat or fabric.
4. Liner Adhesive: Comply with ASTM C 916, Type I.

E. Condensate Drain Pans: Formed sections of galvanized-steel sheet, a minimum of 2 inches deep, and complying with ASHRAE 62.1-2004.

1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.

2. Drain Connections: Threaded nipple, both sides of drain pan.
3. Pan-Top Surface Coating: Corrosion-resistant compound.

F. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

2.3 FANS

A. Direct-Driven Supply-Air Fans: Double width, forward curved, centrifugal; with permanently lubricated, motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.

B. Belt-Driven Supply-Air Fans: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the casing. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.

C. Condenser-Coil Fan: Propeller, mounted on shaft of permanently lubricated motor.

D. Exhaust-Air Fan: Centrifugal, belt-drive, with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the casing. Heavy gauge steel and factory applied acid resistance coating.

E. Fan Motor: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.4 COILS

A. Supply-Air Refrigerant Coil:

1. Aluminum-plate fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor.
2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
3. Coil Split: Interlaced.
4. Condensate Drain Pan: Galvanized steel with corrosion-resistant coating formed with pitch and drain connections complying with ASHRAE 62.1-2004.

B. Outdoor-Air Refrigerant Coil:

1. Aluminum-plate fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor.
2. Polymer strip shall prevent all copper coils from contacting steel coil frame or condensate pan.

2.5 REFRIGERANT CIRCUIT COMPONENTS

A. Number of Refrigerant Circuits: One or two for large units.

B. Compressor: Hermetic, scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief, and crankcase heater.

C. Refrigeration Specialties:

1. Refrigerant: R-407C or R-410A.
2. Expansion valve with replaceable thermostatic element.
3. Refrigerant filter/dryer.
4. Manual-reset high-pressure safety switch.
5. Automatic-reset low-pressure safety switch.
6. Minimum off-time relay.
7. Automatic-reset compressor motor thermal overload.
8. Brass service valves installed in compressor suction and liquid lines.

2.6 AIR FILTRATION

A. Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

1. Pleated: Minimum 60 percent arrestance for supply air and exhaust air.

2.7 GAS FURNACE

A. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47 and NFPA 54.

1. CSA Approval: Designed and certified by and bearing label of CSA.

B. Burners: Corrosion resistant progressive tubular aluminized steel heat exchanger throughout.

1. Fuel: Natural gas.
2. Ignition: Electronically controlled electric spark or hot-surface igniter with flame sensor.
3. High-Altitude Model: For Project elevations more than 6500 feet above sea level.

C. Venting: Gravity vented.

D. Safety Controls:

1. Gas Control Valve: Two stage.

2. Gas Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.

2.8 DAMPERS

A. Outdoor-Air Damper: Linked damper blades, for 0 to 100 percent outdoor air for air side economizer, with motorized damper filter.

B. Outdoor- and Return-Air Mixing Dampers: Parallel- or opposed-blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.

1. Damper Motor: Modulating with adjustable minimum position.
2. Relief-Air Damper: Gravity actuated or motorized, as required by ASHRAE/IESNA 90.1-2004, with bird screen and hood.

2.9 ELECTRICAL POWER CONNECTION

A. Provide for single connection of power to rooftop unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

B. Provide dedicated power for exhaust fan with unit-mounted disconnect switch accessible from outside unit.

2.10 CONTROLS

A. AHU Controls:

1. Factory wired and tested with all necessary safety controls and all controls for fully automatic operation per the sequence of operations on the drawings. AC unit must be capable of fully automatic operation in a local mode in the event that communication with the FMS is lost. See controls drawings for the intended sequence of control and for the points associated with the FMS.
2. Include the necessary functionality to allow all user interface (for both initial setup and ongoing operation) to be through the FMS, and to accomplish the following through a BACNET protocol interface:

Function	**What is by the AC Unit**	**What is by the FMS**
Supply Temperature	Unit Control (Note 1)	Reset supply temp setpoint
Space Temperature Control	Unit Control (Note 3)	Monitor and reset setpoint
Fan Speed Control	Unit Control (Note 3)	Monitor duct SP, and reset control setpoint
Economizer	Unit Control	Monitor Return/Relief Damper Control
Control Monitor	OA Damper Control (Note 2)	Unit Control setpoint adjustment
Building SP Control		
Units 20 Tons & Smaller	All Measurement and Control	Monitor and Trend

Units 25 Tons & Larger	All Measurement and Control	Monitor and Trend
Measure OA Supply		
15 – 20 T Units	All Measurement and Control	Monitor and Trend
25 – 130 T Units	All Measurement and Control	Monitor and Trend
Scheduling Unit Operation		User interface, unit start/stop
Morning Warmup/Cooldown	Unit Control	Signal to initiate and terminate
Unoccupied Control	Unit Control	Signal to initiate and terminate
Duct Static Press Safeties	Unit Control	Measure and Monitor
System Alarms	Unit Control	Monitor and Reset Alarms
Note 1: It is not acceptable to control the AC Unit heating and cooling systems based on return air temperature.		
Note 2: OA supply reset (based on room CO_2 levels). See floor plans for sensors location (return air duct). Include all functionality so the AC Unit can reset the minimum OA supply setpoint based on CO_2 levels measured and transmitted through the FMS.		
Note 3: For single zone applications only.		

a. Include the necessary functionality to exchange all points with the FMS as indicated on the controls drawings and sequence of operations.
b. Provide remote-mounted human interface panel to allow diagnosing and programming unit in the event that FMS connection has failed, and without having to go to unit.
c. Ventilation Over-ride Control: To increase to 100% OA, initiated through the FMS and the Human Interface Panel.
d. Work with the FMS contractor to integrate the AC unit controls with the FMS controls.
e. Work with the FMS contractor for installation of all field-mounted controls supplied with the AC Unit.

2.11 ACCESSORIES

A. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required.

B. Coil guards of painted, galvanized-steel wire.

C. Hail guards of galvanized steel, painted to match casing.

2.12 ROOF CURBS

A. Roof curbs: Custom – Refer to drawings and sections.

B. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.

1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

a. Materials: ASTM C 1071, Type I or II.
b. Thickness: 1 inch.

2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.

a. Liner Adhesive: Comply with ASTM C 916, Type I.
b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
d. Liner Adhesive: Comply with ASTM C 916, Type I.

C. Curb Height: 30 inches.

2.13 HEAT RECOVERY COIL

A. Heat Recovery Coil: Heat Pipe, Colmac Coil Manufacturing, Inc. or approved equal.

B. Heat pipe shall transfer heat between air streams in counter-flow arrangement and shall have no moving parts.

C. One inch aluminum seamless tube with factory applied acid resistance coating on exhaust side.

D. Stainless steel drain pans.

2.14 CAPACITIES AND CHARACTERISTICS

A. Supply and exhaust fans: See Equipment Schedule.

B. Heating and cooling: See Equipment Schedule.

C. Sound Power: Radiated from condenser casing.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Roof Curb: Install on roof structure or concrete base, level and secure, according to ARI Guideline B. Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Division 07 Section "Roof Accessories." Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.

B. Unit Support: Install unit level on structural curbs. Coordinate wall penetrations and flashing with wall construction. Secure RTUs to structural support with anchor bolts.

C. Install condensate drain, minimum connection size, with trap and indirect connection. See Plumbing drawings.

D. Install piping adjacent to RTUs to allow service and maintenance.

1. Gas Piping: Comply with applicable requirements in Division 23 Section "Facility Natural-Gas Piping" Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.

E. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:

1. Install ducts to termination at top of roof curb.
2. Connect supply ducts to RTUs with flexible duct connectors specified in Division 23 Section.
3. Install return-air duct continuously through roof structure.

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. Report results in writing.

B. 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. Report results in writing.

C. Tests and Inspections:

1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
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.

D. Remove and replace malfunctioning units and retest as specified above.

3.3 CLEANING AND ADJUSTING

A. 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 site during other-than-normal occupancy hours for this purpose.

B. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

END OF SECTION 23 7413

SECTION 238126 - VARIABLE REFRIGERANT FLOW (VRF) AIR CONDITIONING THREE PIPE HEAT RECOVERY

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 Multiple Evaporator, Direct Expansion (DX), Air-Cooled, Variable Capacity, split-system air-conditioning and Heat-Pump units consisting of separate evaporator-fan and compressor-condenser components.

1.3 RELATED SECTIONS

A. Section 23 0500, Common Work Requirements for HVAC.

B. Section 23 2313, Variable Refrigerant Flow Piping Systems

C. Section 23 0700, HVAC Insulation.

D. Section 23 0900, Facility Management System.

E. Division 26, Electrical.

F. Refrigerant piping, insulation, and accessories associated with medical equipment and kitchen equipment furnished under other sections of this specification shall be furnished and installed by the equipment sub-contractors and is not a part of Division 23.

1.4 STORAGE, HANDLING AND TRANSPORTATION

A. The storage, handling, and transportation of all refrigerants, oils, lubricants, etc. shall be accomplished in strict compliance with all State, local, and Federal Regulations including all requirements set forth by the Environmental Protection Agency (EPA) for the safe handling of regulated refrigerants and materials. The Contractor shall utilize qualified and/or certified personnel and equipment as prescribed by these requirements. In no situation shall any refrigerant be discharged to the atmosphere. All refrigerants recovered from all systems shall be returned to the Owner.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Shop Drawings: 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.

1.6 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Warranty: Sample of special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.8 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. Filters: One set(s) for each indoor unit.

1.9 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:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - " Procedures," and Section 7 - "Construction and System Start-up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.10 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of equipment that fails in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: Manufacturer's standard, but not less than six years from date of Substantial Completion.
2. Warranty Period for Parts and Labor: Manufacturer's standard, but not less than 1 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by:

1. Daikin
2. Equal upon prior approval.

2.2 INDOOR UNITS

Concealed Ceiling Ducted Unit (Med. Static)

A. The indoor unit shall be a built-in ceiling concealed fan coil unit, operable with refrigerant R-410A, equipped with an electronic expansion valve, direct-drive DC (ECM) type fan with auto CFM adjustment at commissioning, for installation into the ceiling cavity. It is constructed of a galvanized steel casing. It shall be a horizontal discharge air with horizontal return air configuration. All models feature a low height cabinet making them applicable to ceiling pockets that tend to be shallow. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. Included as standard equipment, a condensate drain pan and drain pump kit that pumps to 18-3/8” from the drain pipe opening. The indoor units sound pressure shall range from 29 dB(A) to 40 dB(A) at low speed measured 5 feet below the ducted unit.

B. Performance: See equipment schedule.

C. Indoor Unit:

1. The indoor unit FXMQ_P shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, self-diagnostics, auto-restart

function, 3-minute fused time delay, and test run switch. The unit shall be equipment with an automatically adjusting external static pressure logic selectable during commissioning. This adjusts the airflow. based on the installed external static pressure.

2. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
3. Both refrigerant lines shall be insulated from the outdoor unit.
4. The indoor units shall be equipped with a condensate pan and condensate pump. The condensate pump provides up to 18-3/8" of lift from the center of the drain outlet.
5. The indoor units shall be equipped with a return air thermistor.
6. The indoor unit will be separately powered with 208~230V/1-phase/60Hz.
7. The voltage range will be 253 volts maximum and 187 volts minimum.

D. Unit Cabinet:

1. The cabinet shall be located into the ceiling and ducted to the supply and return openings.
2. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

E. Fan:

1. The fan shall be direct-drive DC (ECM) type fan, statically and dynamically balanced impeller with three fan speeds available.
2. The unit shall be equipment with an automatically adjusting external static pressure logic selectable during commissioning.
3. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output range of 0.12 to 0.47 HP respectively.
4. The airflow rate shall be available in three settings.
5. The fan motor shall be thermally protected.
6. The fan motor shall be equipped as standard with adjustable external static pressure (ESP) settings.

F. Coil:

1. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
3. The coil shall be a 3 row cross fin copper evaporator coil with 13 fpi design completely factory tested.
4. The refrigerant connections shall be flare connections and the condensate will be 1-1/4" outside diameter PVC.
5. A condensate pan shall be located under the coil.
6. A condensate pump with a 18-3/8" lift shall be located below the coil in the condensate pan with a built in safety alarm.
7. A thermistor will be located on the liquid and gas line.

G. Electrical:

1. A separate power supply will be required of 208/230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.

2. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
3. Transmission (control) wiring between the indoor unit and remote controller shall be a maximum distance of 1,640 feet.

2.3 PACKAGED CONTROLS

A. Physical characteristics

1. The unit controls shall be compatible with a Bacnet network for interfacing with the Delta Controls FMS system. See specification section 23 0900 Facility Management System.

B. General:

1. The local remote control shall be made from plastic materials with a neutral color. Each control shall have a LCD (Liquid Crystal Display) that shows set point, room temperature, mode of operation (on/off/cool/heat), and fan speed.

C. Electrical characteristics

1. General:

a. Each VRV system device shall be provided by factory packaged controllers wired to function as a system. The system shall be wired to provide complete functioning of the system. A system user interface that is provided by the VRV system shall be provided at the project site and shall be accessible by VRV equipment representative for remote access by equipment representatives during warranty period. The control and wiring interface shall also include components for interfacing with a Bacnet Network connected to a Facility Management System furnished by a Delta Controls. Access to equipment controls shall be accessible and adjustable from an existing user front end provided by Delta Controls. At the user front end the user shall have access and adjustment of operational schedules, room temperature setpoint adjustment, live temperature conditions, and operational conditions of VRV system components included with this project. Additionally, equipment fault conditions shall be reported to the user front end through the Bacnet network and front end furnished by Delta Controls.

2. Wiring:

a. The control wiring shall be terminated in a daisy chain design from outdoor unit, to branch selector, then daisy chaining to each indoor unit in the system and terminating at the farthest indoor unit. The remote control wiring shall run from the indoor unit control board terminal block to the remote controller connected with that indoor unit.

3. Wiring size:

    a. Wiring shall be non-shielded, 2-conductor sheathed vinyl cord or cable, and 18 AWG stranded copper wire.

D. VRV Controls Network

1. The VRV Controls Network is made up of local remote controllers, multi-zone controllers, and open protocol software devices that transmit information via the high-speed communication bus and can also be controlled via a Bacnet interface for remote and local access. The VRV Controls Network supports operation monitoring, scheduling, error e-mail distribution, general user software, maintenance support, and integration with Facility Management Systems (FMS) using open protocol via BACnet® interface.

E. Bacnet Interface

1. Necessary Bacnet Network hardware, wiring and field configuration shall be provided between VRV packaged controls and Facility Management System furnished and installed by Delta Controls.

    a. Scheduling, Setpoint adjustment, VRV system operation and fault conditions shall be configured and displayed through Bacnet Network to Facility Management System

F. VRV System Controller

1. Necessary hardware, wiring and field configuration shall be provided for access to VRV condensing units and indoor units including setpoint adjustments, scheduling and alarms.

G. Local VRV Indoor Unit Controllers

1. VRV local indoor unit controllers shall be wall mounted and connected to indoor units via non-polar two-wire cabling. The wall-mounted controllers can be adjusted to maintain the optimal operation of the connected indoor unit(s). Setpoint temperatures can be adjusted in increments of 1°F. In the cases where a system or unit error may occur, the VRV controllers will display a two-digit error code and the unit address.

    a. Wall Mounted Controller
        1) Mounting:
            a) The wall mounted controller shall be mounted into a standard 2” x 4” junction box.
        2) Display Features:
            a) The wall mounted controller shall be approximately 4.75” x 4.75” in size with a backlit 2.75” x 1.75” LCD display.
            b) Feature Backlit LCD Display with contrast adjustment and auto off after 30 seconds.
            c) Display information shall be English.
            d) Configurable display mode – Detailed, Standard, and Simple
                Large 11/16” room temperature displayed in Simple display

e) The controller shall display Operation Mode, Setpoint, and Fan Speed.
   Displayed items configurable
   Configure "Off" to be displayed when unit is turned off
   Setpoint can be removed from display when unit is turned Off .
   Fan speed display removable (field setting required)
      Prevents fan speed adjustment
f) System Status icons.
g) The controller shall display temperature setpoint in one degree increments with a range of 60-90°F (16-32°C)
h) Detailed and Simple display will reflect room temperature (0-176°F range in one degree increment).
   Display of temperature information shall be configured for Fahrenheit.
i) On/Off status shall be displayed with an LED.
j) Error codes will be displayed in the event of system abnormality/error with a two digit code.
   A blinking LED will also signal system abnormality/error
k) The following system temperatures can be displayed to assist service personnel in troubleshooting:
   Return Air Temperature
   Liquid Line Temperature
   Gas Line Temperature
   Discharge Air Temperature (depending on unit),
   Remote Controller Sensor Temperature
   Temperature used for Indoor Unit Control

3) Basic Operation:
   a) Controller shall control the following group operations:
      On/Off, Operation Mode (Cool, Heat, Fan, Dry and Auto)
         Configure only the essential modes to be selectable – remove unnecessary mode selection(s) from display
         Independent Cooling and Heating setpoints in the occupied mode
      Single Cooling / Heating setpoint during occupied mode.
   b) Independent Cooling Setup and Heating Setback setpoints in the unoccupied mode
   c) Fan Speed
   d) The controller shall be able to limit the user adjustable setpoint ranges for cooling and heating in the occupied period
   e) Function button lockout (On/Off, Mode, Fan Speed, Up/Down, Left, Right Arrows)
   f) Optional Controller Face Decal to hide unnecessary (locked out) buttons
   g) Clock (12/24 hour) and Day display
   h) Automatic adjustment for Day Light Savings Time (DST)
      Set changeover period (second Sunday in March / first Sunday in November)
4) Programmability:
   a) Controller shall support schedule settings with selectable weekly pattern options.
      7-day

Weekday + Weekend
Weekday + Saturday + Sunday
Everyday
The schedule shall support unit On/Off
Cooling and/or Heating setpoints when unit is on (occupied)
Setup (Cooling) and Setback (Heating) setpoints when unit is off (unoccupied)
A maximum of 5 operations can be schedulable per day
Time setting in 1-minute increments

b) The Controller shall support auto-changeover mode for Heat Recovery systems allowing the optimal room temperature to be maintained by automatically switching the indoor unit's mode between Cool and Heat according to the room temperature and temperature setpoint.
   Changeover to cooling mode shall occur at cooling setpoint + 1°F as the primary changeover deadband
      Configurable from 1 – 4°F with field setting
   Changeover to heating mode shall occur at heating setpoint - 1°F as the primary changeover deadband
      Configurable from 1 – 4°F with field setting
   1 hour guard timer
      - Upon changeover, guard timer will prevent another change over during this period.
      - Guard timer is ignored by a change of setpoint manually from either the Multi-zone Controller, Remote Controller, or by schedule.
      - The Guard timer is also ignored if the space temperature reaches the secondary changeover deadband (configurable from 1 - 4°F (0.5 – 2°C)) from the primary changeover deadband, and the guard timer has been activated
      - 60 minutes as default, configurable to 15, 30, or 90 minutes

c) The Controller shall support an Auto Off Timer for temporarily enabling indoor unit operation during the unoccupied period.
   - When the Off Timer is enabled and when the unit is manually turned on at the remote controller
   - The controller shall shut off the unit after a set time period
   - The time period shall be configurable in the controller menu with a range of 30-180 minutes in 10 minute increments

d) The room temperature shall be sensed at wall mounted controller.

H. VRV Outdoor Unit and Branch Selector Controls.

1. VRV Outdoor Unit controls shall be factory installed and configured to operate in conjunction with associated Indoor Units and Branch Selector units.

   a. Controls shall be configured to provide standard operation of VRV system with Heat Recovery.

1) Provide modulating and staging compressor operation for all modes of operation including heating, cooling, heat recovery, oil return cycle, and defrost cycle.
2) Controls shall be configured to provide operation of condenser fans.
3) Provide automatic rotation of compressor operation.
4) Unit operation be integrated with indoor units and branch selector units provide heat and cooling operations according to scheduling and temperature requirements within the building.
5) Communicate operational condition of internal equipment and associated temperatures through network.
6) Communicate fault conditions of outdoor units through network.

2.4 BRANCH SELECTOR BOX FOR THREE PIPE HEAT RECOVERY SYSTEM

A. General:

1. The branch selector boxes shall be factory assembled, wired, and piped.
2. The branch selector controllers must be run tested at the factory.
3. The branch selector boxes must be mounted indoors.
4. When simultaneously heating and cooling, the units in heating mode shall energize their subcooling solenoid valve.
5. The number of connectable indoor units shall be in accordance with the table below:

Branch Selector Maximum Connectable Cooling Capacity	Maximum Number of Connectable Indoor Units
36,000 Btu/h	5
60,000 Btu/h	8

B. Unit Cabinet:

1. These units shall have a galvanized steel plate casing.
2. Each cabinet shall house multiple refrigeration control valves and a liquid gas separator.
3. The cabinet shall contain a tube in tube heat exchanger.
4. The unit shall have sound absorption thermal insulation material made of flame and heat resistant foamed polyethylene.
5. Nominal sound pressure levels shall be as shown below.

Capacity (Btu/h)	Sound Level dB(A) Operating	Sound Level dB(A) Stopping
36,000	42	32
60,000	43	32

C. Dimensions:

1. Each BSVQ_P unit shall be no larger than 8-3/16” x 15-5/16” x 12-7/8”.

D. Refrigerant Valves:

1. The unit shall be furnished with 5 electronic expansion valves to control the direction of refrigerant flow.
2. The refrigerant connections must be of the braze type.
3. Each circuit shall have at least one (36,000 Btu/h indoor unit or smaller for the BSVQ36PVJU and 60,000 Btu/h indoor unit or smaller for the BSVQ60PVJU) branch selector box.
4. Multiple circuits may be connected to a branch selector box with the use of a EFNET™ joint provided they are within the capacity range of the branch selector.

E. Condensate Removal:

1. The unit shall not require provisions for condensate removal.

F. Electrical:

1. The unit electrical power shall be 208/230 volts, 1 phase, 60 hertz.
2. The unit shall be capable of operation within the limits of 187 volts to 255 volts.
3. The minimum circuit amps (MCA) shall be 0.1 and the maximum fuse amps (MFA) shall be 15.
4. The control voltage between the indoor and outdoor unit shall be 16VDC non-shielded 2 conductor cable

2.5 OUTDOOR UNIT

A. General:

1. The outdoor unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports and refrigerant regulator.
2. High/low pressure gas line, liquid and suction lines must be individually insulated between the outdoor and indoor units.
3. The outdoor unit can be wired and piped with outdoor unit access from the left, right, rear or bottom.
4. The connection ratio of indoor units to outdoor unit shall be permitted up to 150%.
5. Each outdoor system shall be able to support the connection of up to 41 indoor units dependant on the model of the outdoor unit.
6. The system will automatically restart operation after a power failure and will not cause any settings to be lost, thus eliminating the need for reprogramming.
7. The unit shall incorporate an auto-charging feature and a refrigerant charge check function.
8. The outdoor unit shall be modular in design and should allow for side-by-side installation with minimum spacing.
9. The following safety devices shall be included on the condensing unit; high pressure switch, control circuit fuses, crankcase heaters, fusible plug, high pressure switch, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.

10. To ensure the liquid refrigerant does not flash when supplying to the various indoor units, the circuit shall be provided with a sub-cooling feature.
11. Oil recovery cycle shall be automatic occurring 2 hours after start of operation and then every 8 hours of operation.
12. The outdoor unit shall be capable of heating operation at 0°F dry bulb ambient temperature without additional low ambient controls.
13. The system shall continue to provide heat to the indoor units in heating operation while in the defrost mode.
14. Performance: See equipment schedule.

B. Unit Cabinet:

1. The outdoor unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish.

C. Fan:

1. The condensing unit shall consist of one or more propeller type, direct-drive 350 and 750 W fan motors that have multiple speed operation via a DC (digitally commutating) inverter.
2. The condensing unit fan motor shall have multiple speed operation of the DC (digitally commutating) inverter type, and be of high external static pressure and shall be factory set as standard at 0.12 in. WG. A field setting switch to a maximum 0.32 in. WG pressure is available to accommodate field applied duct for indoor mounting of condensing units.
3. The fan shall be a vertical discharge configuration with a nominal airflow maximum range of 6,700 CFM to 14,120 CFM dependant on model specified.
4. Nominal sound pressure levels shall be as shown below.

UNIT CAPACITY (Btu/h)	Sound Pressure Level dB(A)
72,000	58
96,000	58
120,000	60
144,000	61
168,000	61
192,000	62
216,000	62
240,000	63

5. The fan motor shall have inherent protection and permanently lubricated bearings and be mounted.
6. The fan motor shall be provided with a fan guard to prevent contact with moving parts.
7. Night setback control of the fan motor for low noise operation by way of automatically limiting the maximum speed shall be a standard feature. Operation sound level shall be selectable from 3 steps as shown below.

Operation Sound (dB)	Night Mode Sound Pressure Level (dB)
Step 1 max.	55
Step 2 max.	50
Step 3 max.	45

D. Condenser Coil:

1. The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The heat exchanger coil shall be of a waffle louver fin and rifled bore tube design to ensure high efficiency performance.
3. The heat exchanger on the condensing units shall be manufactured from Hi-X seamless copper tube with N-shape internal grooves mechanically bonded on to aluminum fins to an e-Pass Design.
4. The fins are to be covered with an anti-corrosion acrylic resin and hydrophilic film type E1.
5. The pipe plates shall be treated with powdered polyester resin for corrosion prevention. The thickness of the coating must be between 2.0 to 3.0 microns.

E. Compressor:

1. The inverter scroll compressors shall be variable speed (PAM inverter) controlled which is capable of changing the speed to follow the variations in total cooling and heating load as determined by the suction gas pressure as measured in the condensing unit. In addition, samplings of evaporator and condenser temperatures shall be made so that the high/low pressures detected are read every 20 seconds and calculated. With each reading, the compressor capacity (INV frequency or STD ON/OFF) shall be controlled to eliminate deviation from target value.
2. The inverter driven compressor in each condensing unit shall be of highly efficient reluctance DC (digitally commutating), hermetically sealed scroll “G-type” with a maximum speed of 7,980 rpm.
3. Neodymium magnets shall be adopted in the rotor construction to yield a higher torque and efficiency in the compressor instead of the normal ferrite magnet type. At complete stop of the compressor, the neodymium magnets will position the rotor into the optimum position for a low torque start.
4. The capacity control range shall be as low as 6% to 100%.
5. Each non-inverter compressor shall also be of the hermetically sealed scroll type.
6. Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.
7. Oil separators shall be standard with the equipment together with an intelligent oil management system.
8. The compressor shall be spring mounted to avoid the transmission of vibration.
9. Units sized 8-12 ton shall contain a minimum of 2 compressors, 14-16 ton units shall contain a minimum of 3 compressors and 18-20 ton shall contain a minimum of 4 compressors. In the event of compressor failure the remaining compressors shall continue to operate and provide heating or cooling as required at a proportionally reduced capacity. The microprocessor and associated controls shall be designed to specifically address this condition.

10. In the case of multiple condenser modules, conjoined operation hours of the compressors shall be balanced by means of the Duty Cycling Function, ensuring sequential starting of each module at each start/stop cycle, completion of oil return, completion of defrost or every 8 hours.

F. Electrical:

1. The power supply to the outdoor unit shall be 208-230 volts, 3 phase, 60 hertz +/- 10%.
2. The control voltage between the indoor and outdoor unit shall be 16VDC non-shielded, stranded 2 conductor cable.
3. The control wiring shall be a two-wire multiplex transmission system, making it possible to connect multiple indoor units to one outdoor unit with one 2-cable wire, thus simplifying the wiring operation.
4. The control wiring lengths shall be as shown below.

	Outdoor to Indoor Unit	Outdoor to Central Controller	Indoor Unit to Remote Control
Control Wiring Length	6,665 ft	3,330 ft	1,665 ft
Wire Type	16 AWG, 2 wire, non-polarity, non-shielded, stranded		

G. Options:

1. Outdoor Multi Connection Pipe Kit

PART 3 - EXECUTION

3.1 INSTALLATION

A. The system must be installed by a manufacturer factory trained contractor/dealer. The bidders shall be required to submit training certification proof with bid documents. The mechanical contractor’s installation price shall be based on the systems installation requirements. The mechanical contractor bids with complete knowledge of the HVAC system requirements.

B. Install units level and plumb.

C. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

D. Install roof-mounted, compressor-condenser components on equipment supports specified in Section 07 7200 "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.

E. Equipment Mounting:

1. Install ground-mounted, compressor-condenser components on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

F. Install and connect refrigerant tubing to component's fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

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

B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

C. Duct Connections: Duct installation requirements are specified in Section 23 3113 "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Section 23 3300 "Air Duct Accessories."

3.3 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, 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 motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

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.

3.5 DEMONSTRATION

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

END OF SECTION 238126

SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General Conditions, Supplemental General Conditions, and Division 1 Specification Sections apply to all Sections of Division 26.

B. The requirements listed under General Conditions and Supplementary Conditions and the General Requirements are applicable to this section and all subsequent sections of Division 26 and form a part of the contract.

C. Division 1, Coordination, for additional requirements.

D. Division 1, Cutting and Patching, for additional requirements.

E. Division 1, Submittals, for additional requirements.

F. Division 7, Firestopping, for additional requirements.

G. Division 7, Joint Sealants, for additional requirements.

H. Division 9, Painting, for additional requirements.

I. Division 31, Site Work for Trenching, Backfilling and Compaction requirements.

1.2 SUMMARY

A. This Section includes general administrative and procedural requirements of electrical installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division 1:

1. Submittals
2. Coordination Drawings
3. Record Documents
4. Maintenance Manuals
5. Rough-Ins
6. Electrical Installations
7. Cutting and Patching

1.3 ELECTRICAL DIVISION INDEX

Section 26 0500	Common Work Results for Electrical
Section 26 0519	Low Voltage Electrical Power Conductors and Cables
Section 26 0526	Grounding and Bonding for Electrical Systems
Section 26 0529	Hangers and Supports for Electrical Systems
Section 26 0533	Raceway and Boxes for Electrical Systems
Section 26 0553	Identification for Electrical Systems

Section 26 0923	Lighting Control Devices
Section 26 2416	Panelboards
Section 26 2726	Wiring Devices
Section 26 2813	Fuses
Section 26 2816	Enclosed Switches and Circuit Breakers
Section 26 4313	Surge Protection Devices for Low Voltage Electrical Power Circuits
Section 26 5100	Interior Lighting

1.4 CODES AND PERMITS

A. Perform electrical work in strict accordance with the applicable provisions of the National Electrical Code, Latest Edition; National Electric Safety Code, Latest Edition, the Uniform International Building Code, Latest Edition as adopted and interpreted by the State of New Mexico, City of Lovington, and the National Fire Protection Association (NFPA Regulations), current adopted edition. Provide all materials and labor necessary to comply with rules, regulations and ordinances. Where the drawings and/or specifications indicate materials or construction in excess of code requirements, the drawings and/or specifications shall govern. The Contractor shall hold and save the Engineer free and harmless from liability of any nature or kind arising from his failure to comply with codes and ordinances.

B. Secure and pay for all permits necessary for performance of the work. Pay for all utility connections unless otherwise specified herein.

C. The following lists applicable codes and standards that, as a minimum, shall be followed.

Applicable county and state electrical codes, laws and ordinances.
National Electrical Manufacturer's Association Standards
National Electrical Code
National Electrical Safety Code
Underwriters Laboratories, Inc. Standards
American National Standards Institute
American Society for Testing Materials Standards
Standards and requirements of local utility companies
National Fire Protection Association Standards
Institute of Electrical and Electronics Engineers Standards
Insulated Cable Engineers Association
Occupational Safety and Health Act
Uniform Fire Code
Americans with Disabilities Act
Commercial and Industrial Insulation Standards (MICA)

1.5 RECORD DRAWINGS

A. Maintain a complete and accurate set of marked up blue-line prints showing information on the installed location and arrangement of all electrical work, and in particular, where changes were made during construction. Use red color to indicate additions or corrections to prints, green color to indicate deletions, and yellow color to indicate items were installed as shown. Keep record drawings accurate and up-to-date throughout the construction period. Record drawings may be reviewed and checked by the Architect, Owner's Representative and Contracting Officer during the construction

and in conjunction with review and approval of monthly pay requests. Include copies of all addenda, RFI's, bulletins, and change orders neatly taped or attached to record drawing set. Transmit drawings to the Architect at the conclusion of the project for delivery to the Owner's Representative.

1.6 QUALIFICATIONS

A. All electricians shall be skilled in their respective trade.

1.7 SUBSTITUTIONS

A. Identification of Division 26 equipment, fixtures, and materials listed within this Specification and in the Equipment Schedules on the drawings, which are identified by manufacturer's name, trade name, and/or model numbers are generally not meant to give preference to any manufacturer, but are provided to establish the design requirements and standards.

B. Equipment submitted for substitution must fit the space conditions leaving adequate room for maintenance around all equipment. A minimum of 36 inches, or more if required by Code, must be maintained clear in front of all electrical panels, starters, gutters, or other electrical apparatus. Submit drawings showing the layout, size and exact method of interconnection of conduit, wiring and controls, which shall conform to the manufacturer's recommendations and these specifications. The scale of these drawings shall be scale of Contract Drawings. The Contractor shall bear the excess costs, by any and all crafts, of fitting the equipment into the space and the system designated. Where additional labor or material is required to permit equipment submitted for substitution to function in an approved manner, this shall be furnished and installed by the Contractor without additional cost to the Owner.

C. Equipment submitted for substitution shall be approved in writing by the Owner or his representative and shall be accompanied by the following:

1. A sample of each item submitted for substitution shall accompany the submittal.
2. Provide a unit price quotation with each item intended for substitution. Include a unit price for the specified item and a unit price for the intended substitute item. Provide a total (per item) of the differential payback to the Owner should the intended substitute item be approved as equivalent to that which is specified.
3. Reimburse the Owner for the Architect/Engineer's additional services required to review and process substitutions.

D. Substitutions shall be approved in writing by the Owner or his representatives. The determination of the Owner shall be final.

1.8 PRIOR APPROVAL

A. Requirements for prior approval in Division 1 or other sections of this specification do not override the requirements of this section.

1.9 HAZARDOUS CONDITIONS

A. Protruding metal (bolts, steel angles, etc.) potentially hazardous to maintenance and operation personnel, shall be cut back and/or protected to reduce the risk of injury.

1.10 DEFINITIONS

A. Definitions of terms will be found in the National Electrical Code.

B. Whenever a term is used in this Specification which is defined in the Code, the definition given will govern its meaning in this Specification.

C. Whenever a technical term is used which does not appear in the Code, the definition to govern its meaning in these Specifications will be found in the Standard Dictionary of Electrical and Electronic Terms, published by the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, Piscataway, New Jersey 08855-1331.

D. "Provide" means furnish, install, connect and test unless otherwise noted.

1.11 SUBMITTALS

A. The Contractor shall submit submittal brochures of equipment, fixtures and materials to be furnished under Division 26.

B. Unauthorized Substitutions: If substitute materials, equipment or systems are installed without prior review or are installed in a manner which is not in conformance with the requirement of this Specification and for which the Contractor has not received a written review, removal of the unauthorized materials and installation of those indicated or specified shall be provided at no change in contract amount.

C. Install equipment in accordance with the manufacturer's recommendations. Provide accessories and components for optimum operation as recommended by the manufacturer.

D. Costs for the preparation, correction, delivery, and return of the submittals shall be borne by the Contractor.

E. Complete data must be furnished showing performance, quality and dimensions. No equipment or materials shall be purchased prior to receiving written notification from the Architect/Engineer that submittals have been reviewed and marked either "NO EXCEPTIONS TAKEN" or "EXCEPTIONS AS NOTED." Submittals returned marked "EXCEPTIONS AS NOTED" do not require resubmittal provided that the Contractor agrees to comply with all exceptions noted in the submittal, and so states in a letter to the Architect/Engineer.

F. Review of Submittals: Submittals will be reviewed with reasonable promptness, but only for conformance with the design concept of the Project and for conformance with the information indicated on the Drawings and stated in the Specifications. Review of a separate item as such will not indicate review of the assembly in which the item functions. Review of submittals shall not relieve the Contractor of responsibility for any deviation from the requirements of the Contract Documents, nor for errors or omissions in the submittals; or for the accuracy of dimensions and

quantities, the adequacy of connections, and the proper and acceptable fitting, execution, functioning and completion of the work. Review shall not relieve the Contractor of responsibility for the equipment fitting within the allotted space shown on the drawings with all clearances required for equipment operation, service and maintenance including a minimum of 3 feet clear in front of all electrical equipment and panels as defined by the National Electrical Code. Any relocation of mechanical and/or electrical equipment, materials and systems required to comply with minimum clearances shall be provided by the Contractor without additional cost under the Contract.

G. Shop Drawings: Unless the following information is included, shop drawings will be returned unchecked:

1. Cover sheet for each submittal, listing equipment, products, and materials, and referencing data and sections in Specifications and drawings. Clearly reference project name and provide space for a review stamp.
2. Cover sheet shall clearly identify deviations from specifications, and justification.
3. Include all related equipment in a single submittal to allow complete review. Similar equipment may be submitted under a common cover sheet.
4. Size, dimensions, and weight of equipment.
5. Equipment performance under specified conditions, not a copy of scheduled data on drawings.
6. Indicate actual equipment proposed, where data sheets indicate more than one (1) device or equipment.

H. Use of substitutions reviewed and checked by the Engineer does not relieve the Contractor from compliance with the Contract Documents. Contractor shall bear all extra expense resulting from the use of any substitutions where substitutions affect adjoining or related work required in this Division or other Divisions of this Specification.

I. If Contractor substitutes equipment for that drawn to scale on the drawings, he shall prepare a 1/4" = 1'-0" installation drawing for each equipment room where a substitution is made, using dimensions of substituted equipment, and including piping, and electrical equipment requirements, to verify that equipment will fit space with adequate clearances for maintenance. This 1/4" = 1'-0" fabrication drawing shall be submitted, for review by the Architect, with the shop drawing submittals of the substituted. Failure to comply with this requirement will result in the shop drawings being returned unchecked.

J. Submittals and one (1) resubmittal will be reviewed by the Architect/Engineer. If the Contractor fails to provide the required data with his second submittal, he will be charged for the third and subsequent reviews.

K. See Division 1 for additional submission requirements.

1.12 MAINTENANCE MANUALS

A. Prepare maintenance manuals in accordance with Division 1, Section 01 78 23 - PROJECT CLOSEOUT. In addition to the requirements specified in Division 1, include the following information for equipment items:

1. Manufacturer’s printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency

instructions; and summer and winter operating instructions.

2. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.

1.13 COORDINATION DRAWINGS

A. Prepare coordination drawings in accordance with Division 1, Section "PROJECT COORDINATION", to a scale of 1/4" = 1'-0" or larger; detailing major elements, components, and systems of electrical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:

1. Indicate the proposed locations of major raceway systems, equipment, and materials. Include the following:

    a. Clearances for servicing equipment, including space for equipment disassembly required for periodic maintenance.
    b. Exterior wall and foundation penetrations.
    c. Fire-rated wall and floor penetrations.
    d. Equipment connections and support details.
    e. Sizes and location of required concrete pads and bases.
2. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
3. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
4. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communications systems components, sprinklers, and other ceiling-mounted devices.

1.14 USE OF CADD FILES

A. Under certain conditions, the Contractor will be permitted the use of the Engineer's CADD files for documentation of as-builts, submittals, or coordination drawings.

B. The Engineer shall be compensated for the time required to format the CADD files for delivery to the Contractor. Such work may include removal of title blocks, professional seals, calculations, proprietary information, etc.

C. The Contractor shall complete the enclosed License, Indemnity and Warranty Agreement, complete with contractor's name, address, and Contractor's Representative signature prior to request for CADD file usage.

1.15 DRAWINGS AND SPECIFICATIONS

A. Electrical drawings are diagrammatic, but shall be followed as closely as actual construction and work of the other sections shall permit. Size and location of equipment is drawn to scale wherever possible. Do not scale from electrical drawings.

B. Drawings and specifications are for the assistance and guidance of the Contractor. Exact locations, distances, and levels will be governed by the building. The Contractor shall make use of data in all the Contract Documents to verify information at the building site.

C. In any case where there appears to be a conflict between that which is shown on the electrical drawings, and that shown in any other part of the Contract Documents, the Contractor shall notify and secure directions from the Architect.

D. Drawings and specifications are intended to complement each other. Where a conflict exists between the requirements of the drawings and/or the specifications, request clarification. Do not proceed with work without direction.

E. The Architect shall interpret the drawings and the specifications. The Architect's interpretation as to the true intent and meaning thereof and the quality, quantity, and sufficiency of the materials and workmanship furnished there under shall be accepted as final and conclusive.

F. In the case of conflicts not clarified prior to the bidding deadline, use the most costly alternative (better quality, greater quantity, and larger size) in preparing the bid. A clarification will be issued to the successful bidder as soon as feasible after the award and, if appropriate, a deductive change order will be issued.

G. Where items are specified in the singular, this division shall provide the quantity as shown on drawings plus any spares or extras indicated on the drawings or in the specifications.

H. Investigate structural and finish conditions and arrange work accordingly. Provide all fittings, equipment, and accessories required for actual conditions.

1.16 SIMILAR MATERIALS

A. All items of a similar type shall be products of the same manufacturer.

B. Contractor shall coordinate among suppliers of various equipment to assure that similar equipment type is product of the same manufacturer.

C. Examples of similar equipment types include but are not limited to:

1. Power Circuit Breakers
2. Enclosed Case Circuit Breakers
3. Batteries
4. UPS
5. TVSS
6. Engine-Generators
7. Motor Starters
8. Transformers
9. Panelboards
10. Disconnects
11. Fuses
12. Transfer Switch
13. Computer Power Distribution Units

1.17 DELIVERY, STORAGE AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

1.18 GUARANTEE-WARRANTY

A. See Division 1 for warranties.

PART 2 - PRODUCTS

2.1 QUALITY OF MATERIALS

A. All equipment and materials shall be new, and shall be the standard product of manufacturers regularly engaged in the production of electrical equipment, and shall be the manufacturer's latest design. Specific equipment, shown in schedules on drawings and specified herein, is to set forth a standard of quality and operation.

B. Hazardous or Environmentally Damaging Materials: Products shall not contain asbestos, mercury, PCBs, or other materials harmful to people or the environment.

2.2 ALTITUDE RATINGS

A. Unless otherwise noted, all specified equipment capacities are for an altitude of this project site. Contractor will verify altitude of site prior to ordering any equipment. Adjustments to manufacturer's ratings must be made accordingly.

2.3 EQUIPMENT REQUIREMENTS

A. Approved Equipment and Conductors: ALL equipment and conductors shall be listed and labeled by a nationally recognized testing laboratory (NRTL). The NRTL shall be listed by the federal occupational safety and health administration. Conformance with the State of New Mexico Electrical Code article 110.2 is required for ALL equipment and conductors.

PART 3 - EXECUTION

3.1 COOPERATION WITH OTHER TRADES

A. Coordinate all work so that the construction operations can proceed without harm to the Owner from interference, delay, or absence of coordination. The Contractor shall be responsible for the size and accuracy of all openings.

3.2 DRAWINGS

A. The electrical drawings show the general arrangement of all lighting, power, special systems, equipment, etc., and shall be followed as closely as actual building construction and work of other trades will permit. Whenever discrepancies occur between plans and specifications, the most stringent shall govern. All Contract Documents shall be considered as part of the work. Coordinate with architectural, mechanical, and structural drawings. Because of the small scale of the electrical drawings, it is not possible to indicate all offsets, fittings and accessories which may be required. Provide all fittings, boxes, and accessories as may be required to meet actual conditions. Should conditions necessitate a rearrangement of equipment, such departures and the reasons therefore, shall be submitted by the Contractor for review in the form of detailed drawings showing the proposed changes. No changes shall be made without the prior written approval. All changes shall be marked on record drawings.

B. Should any doubt or question arise in respect to the true meaning of the drawings or specifications, the question shall be submitted in writing.

C. Installation of all equipment shall be arranged to provide all clearances required for equipment operation, service, and maintenance, including minimum clearance, as defined by the National Electrical Code (NEC).

D. The Contractor's attention is directed to the unique architectural design features and consideration associated with this facility which will require significantly greater levels of coordination and cooperation for the work furnished and installed under Division 26 with the associated architectural, structural, and mechanical work than is normally necessary for a more typical facility.

E. The installation of all concealed electrical systems shall be carefully arranged to fit within the available space without interference with adjacent structural and mechanical systems.

3.3 ELECTRICAL INSTALLATIONS

A. General: Sequence, coordinate, and integrate the various elements of electrical system, materials, and equipment. Comply with the following requirements:

1. Coordinate electrical systems, equipment, and materials installation with all other building components.
2. Verify all dimensions by field measurements.
3. Arrange for chases, slots, and openings in all other building components during progress of construction, to allow for electrical installations.
4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components as they are constructed.
5. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum clearance possible.
7. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
8. Branch circuits in offices and computer areas to have an individual neutral for each phase.

9. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.
10. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components.
11. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
12. Install access panel or doors where units are concealed behind finished surfaces.

13. Install systems, materials, and equipment giving right-of-way priority to systems requiring installation at a specified slope.

3.4 FIELD MEASUREMENTS

A. No extra compensation shall be claimed or allowed due to differences between actual dimensions, including dimensions of equipment, fixtures and materials furnished, and those indicated on the drawings. Contractor shall examine adjoining work, and shall report any work which must be corrected. Review of submittal data in accordance with paragraph "Submittals" shall in no manner relieve the Contractor of responsibility for the proper installation of the electrical work within the available space. Installation of equipment and systems within the building space shall be carefully coordinated by the Contractor.

3.5 EQUIPMENT SUPPORT

A. Provide support for equipment to the building structure. Provide all necessary structures, inserts, sleeves, firestops and hanging devices for installation of equipment. Coordinate installation of devices. Verify with the Architect that the devices and supports are adequate as intended and do not overload the building's structural components in any way.

3.6 PAINTING

A. All finish painting of electrical systems and equipment will be under "Painting," unless equipment is hereinafter specified to be painted.

B. All equipment shall be provided with factory applied standard finish, unless otherwise specified.

C. Touch-Up: If the factory finish on any equipment is damaged in shipment or during construction of the building, the equipment shall be refinished to the satisfaction of the Architect, Owner's Representative, and Building Manager.

3.7 PROTECTION OF MATERIALS AND EQUIPMENT

A. The Contractor shall be responsible for the protection of all work, materials and equipment furnished and installed under this section of the specifications, whether incorporated in the building or not.

B. All items of electrical equipment shall be stored in a protected weatherproof enclosure prior to installation within the building, or shall be otherwise protected from the weather in a suitable manner approved by the Architect, and Owner's Representative.

C. The Contractor shall provide protection for all work and shall be responsible for all damage done to property, equipment and materials. Storage of materials within the building shall be approved by the Architect and Owner's Representative prior to such storage.

D. Conduit openings shall be closed with caps or plugs, or covered to prevent lodgment of dirt or trash during the course of installation. At the completion of the work, fixtures, equipment and materials shall be cleaned and polished thoroughly and delivered in a condition satisfactory to the Architect, and Owner's Representative**.**

3.8 EXCAVATION

A. Provide all excavation, trenching and backfilling required.

B. Slope sides of excavations to comply with codes and ordinances. Shore and brace as required for stability of excavation.

3.9 ERECTION OF METAL SUPPORTS AND ANCHORAGE

A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

B. Field Welding: Comply with AWS "Structural Welding Code."

3.10 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

B. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.11 APPLICATION OF JOINT SEALERS

A. General: Comply with joint sealer manufacturer’s printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.
   1. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.
   2. Comply with recommendations of ASTM C 790 for use of acrylic-emulsion joint sealants.

B. Immediately after sealant application and prior to time shinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant

with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

C. Firestopping Sealant: Provide sealant, including forming, packing, and other accessory materials, to fill openings around electrical services penetrating floors and walls, to provide fire-stops with fire-resistance ratings indicated for floor or wall assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency.

3.12 INSTALLATION OF ACCESS DOORS

A. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.

B. Adjust hardware and panels after installation for proper operation.

3.13 CUTTING AND PATCHING

A. Perform cutting and patching in accordance with Division 1, Section "CUTTING AND PATCHING." In addition to the requirements specified in Division 1, the following requirements apply:

1. Perform cutting, fitting, and patching of electrical equipment and materials required to:
    a. Remove and replace defective Work.
    b. Remove and replace Work not conforming to requirements of the Contract Documents.
    c. Remove samples of installed Work as specified for testing.
    d. Install equipment and materials in existing structures.
    e. Upon written instructions from the Contracting Officer, uncover and restore Work to provide for Contracting Officer observation of concealed Work.
2. Cut, remove, and legally dispose of selected electrical equipment, components, and materials as indicated, including but not limited to removal of electrical items indicated to be removed and items made obsolete by the new Work.
3. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
4. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
5. During cutting and patching operations, protect adjacent installations.
6. Patch existing finished surfaces and building components using new materials matching existing materials and experienced installers.

3.14 MANUFACTURER'S INSTRUCTIONS

A. All equipment shall be installed in strict accordance with recommendations of the manufacturer. If such recommendations conflict with plans and specifications, the Contractor shall submit such conflicts to the Architect, and Owner's Representative who shall make such compromises as he deems necessary and desirable.

3.15 OWNER FURNISHED EQUIPMENT

A. Some equipment has either been pre-purchased or is in the process of being pre-purchased by the Owner. It has been necessary to take this approach in order to meet the construction deadlines of the project. The pre-purchased equipment will be indicated on the drawings.

B. Included in Work Scope:

1. Follow and expedite the delivery of each piece of equipment to assure the equipment delivery stays on schedule. Notify the Owner of any problems or delays.
2. Receive, unload, uncrate, and install each item of pre-purchased and Owner furnished equipment.
3. Confirm that each item has been received complete and as specified. Notify the Owner and the manufacturer's representative in writing of any deficiencies or damage.
4. Coordinate with the manufacturer's representative on start-up and provide factory personnel and provide all necessary personnel to assist Owner's operating personnel and/or manufacturer's service personnel in start-up and commissioning.
5. Provide all items not listed as pre-purchased.

C. Submittals, installation instructions, and warranty provisions for pre-purchased equipment will be furnished to the Contractor by the Owner.

3.16 CONCRETE BASES AND HOUSEKEEPING PADS

A. Install concrete bases and housekeeping pads under all freestanding electrical equipment unless otherwise noted.

B. Contractor shall be responsible for the accurate dimensions of all pads and bases and shall furnish and install all anchor bolts, etc. Coordinate weight of concrete bases and housekeeping pads with the structural engineer.

C. All concrete bases and housekeeping pads shall conform to the requirements specified under Division 3, Concrete, portions of these specifications. Pad foundations shall be 4" high minimum, unless otherwise indicated on the drawings. Chamfer edges shall be 1". Faces shall be free of voids and rubbed smooth with Carborundum block after stripping forms. Tops shall be level. Provide dowel rods or other required material in floor for lateral stability and anchorage.

3.17 TESTS

A. All tests shall be conducted in the presence of the designated and authorized Owner's Representative. The Contractor shall notify the Architect, and Owner's Representative two weeks in advance of all tests. The Contractor shall furnish all necessary equipment, materials, and labor to perform the required tests.

3.18 OPERATION AND MAINTENANCE INSTRUCTIONS

A. The Contractor shall furnish the complete operating and maintenance instructions covering all units of electrical equipment herein specified together with parts lists. Furnish four (4) copies of all the

literature; each shall be suitably bound in loose leaf book form.

B. Operating and maintenance manuals as required herein shall be submitted for review not less than two (2) weeks prior to the date scheduled for the Contractor to provide Operating and Maintenance Instructions to the Owner as specified herein.

C. Upon completion of all work and all tests, Contractor shall furnish the necessary skilled labor and helpers for operating the electrical systems and equipment for a period of three (3) days of eight (8) hours each. During this period, the Contractor shall instruct the Owner or his representative in the operations, adjustment and maintenance of all equipment furnished. Contractor shall provide at least two weeks notice in advance of this period, with a written schedule of each training session, the subject of the session, the Contractors' representatives who plan to attend the session, and the time for each session.

D. The Contractor shall video tape the instruction and training sessions using a VHS or DVD camcorder, and at the completion and acceptance (by Owner and Architect) of the training sessions, the Contractor shall submit (2) copies of the video tape.

3.19 CERTIFICATIONS

A. Before receiving final payment, certify in writing that all equipment furnished and all work done is in compliance with all applicable codes mentioned in these specifications. Submit certifications and acceptance certificates to the Architect, and Owner's Representative including proof of delivery of O&M manuals, spare parts required, and equipment warranties which shall be bound with O&M manuals.

3.20 INTERRUPTING SERVICES

A. Contractor shall coordinate the installation of all work within the building in order to minimize interference with the operation of existing building electrical telephone, fire alarm, and utility systems during construction. Connections to existing systems requiring the interruption of service within the building shall be carefully coordinated with the Owner to minimize system downtimes. Requests for the interruption of existing services shall be submitted in writing a minimum of two (2) weeks before the scheduled date. Absolutely no interruption of the existing services will be permitted without the written review.

3.21 OPERATION PRIOR TO ACCEPTANCE

A. Operation of equipment and systems installed by the Contractor for the benefit of the Owner prior to substantial completion will be allowed providing a written agreement between the Owner and the Contractor has established warranty and other responsibilities to the satisfaction of both parties.

B. Operation of equipment and systems installed by the Contractor, for the benefit of the Contractor, except for the purposes of testing and balancing will not be permitted without a written agreement between the Owner and the Contractor establishing warranty and other responsibilities.

3.22 SITE VISITS AND OBSERVATION OF CONSTRUCTION

A. The Architect/Engineer will make periodic visits to the project site at various stages of construction in order to observe the progress and quality of various aspects of the Contractor's work, in order to determine in general if such work is proceeding in accordance with the Contract Documents. This observation by the Architect/Engineer however, shall in no way release the Contractor from his complete responsibility to supervise, direct, and control all construction work and activities, nor shall the Architect/Engineer have authority over, or a responsibility to means, methods, techniques, sequences, or procedures of construction provided by the Contractor or for safety precautions and programs, or for failure by the Contractor to comply with all law, regulations, and codes.

END OF SECTION 260500

DIVISION 26 SUBSTITUTION REQUEST FORM (SRF)

TO: BRIDGERS & PAXTON CONSULTING ENGINEERS, INC.
PROJECT:_____
We hereby submit for your consideration the following product instead of the specified item for the above project:
Section: _____ Page:_____ Paragraph/Line:_____ Specified Item:_____
Proposed Substitution: _____
Attach complete product description, drawings, photographs, performance and test data, and other information necessary for evaluation. Identify specific Model Numbers, finishes, options, etc.

1. Will changes be required to building design in order to properly install proposed substitutions? YES ☐ NO ☐
   If YES, explain:_____
2. Will the undersigned pay for changes to the building design, including engineering and drawing costs, caused by requested substitutions? YES ☐ NO ☐
3. List differences between proposed substitutions and specified item.

Specified Item	Proposed Substitution
_____	_____
_____	_____
_____	_____

4. Does substitution affect Drawing dimensions? YES ☐ NO ☐
5. What affect does substitution have on other trades? _____
   _____
6. Does the manufacturer's warranty for proposed substitution differ from that specified? YES ☐ NO ☐
   If YES, explain:_____
   _____
7. Will substitution affect progress schedule? YES ☐ NO ☐
   If YES, explain:_____
   _____
8. Will maintenance and service parts be locally available for substitution? YES ☐ NO ☐
   If YES, explain:_____
   _____
9. Is substitution identical in appearance and function to specialized product? YES ☐ NO ☐

Submitting Firm: _____ Date: __
Address: _____
Signature: _____ Telephone: _____

For Engineer's Use Only
Accepted:_____ Not Accepted:_____ Received Too Late:_____
By:_____ Date:_____
Remarks:_____

LICENSE AGREEMENT FOR CADD DATABASE OR BIM MODEL

PROJECT: _____

LICENSE GRANT: Contractor is granted use of the CADD Database or BIM Model (Database/Model) for the indicated project for the specific purpose of preparing submittal documents for this Project. No other use of the Database/Model is granted. Title to the Database/Model is not transferred to the Contractor. The Database/Model may be of value to the Contractor in preparing submittals, but use of the model does not relieve the contractor of the requirement to verify measurements in the field.

COPYING RESTRICTIONS: Contractor may copy the Database/Model in whole or in part, but only for backup and archival purposes or for use by the Contractor's Subcontractors. Contractor agrees to ensure that any entities that receive the Database/Model from Contractor, either in whole or in part, comply with the terms and conditions of this agreement. Contractor shall safeguard the Database/Model from falling into the hands of parties other than Subcontractors with a legitimate need for it.

WARRANTY: Bridgers & Paxton (B&P) offers this Database/Model without warranty and specifically without express or implied warranty of fitness. If Contractor chooses to use the Database/Model, then he does so at his own risk and without any liability or risk to B&P.

INDEMNITY: Contractor shall to the fullest extent permitted by law, defend, indemnify and hold harmless the Owner, Architect, B&P, their employees and agents from all claims, damages, losses, and attorney fees arising out of or resulting from the use of the Database/Model.

ACKNOWLEDGMENT: Contractor acknowledges that (s)he has read this Agreement, understands it, and agrees to be bound by its terms and conditions.

CONTRACTOR'S REPRESENTATIVE

Signature: _____ Company Name: _____

Name: _____ Address 1: _____

Title: _____ Address 2: _____

Date: _____

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

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. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.

B. Related Requirements:

1. Section 26 0529 "Hangers and Supports for Electrical Systems” for supports and anchors for fastening cable directly to building finishes.
2. Section 26 0553 "Identification for Electrical Systems" for insulation color coding and wire cable markers.

1.3 DEFINITIONS

A. VFC: Variable frequency controller.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Alcan Products Corporation; Alcan Cable Division.
2. Alpha Wire.
3. Belden Inc.
4. Encore Wire Corporation.
5. General Cable Technologies Corporation.
6. Southwire Incorporated.

B. Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.

C. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Type THW, Type THHN/THWN.

D. Multi-conductor Cable: Comply with NEMA WC 70/ICEA S-95-658 for metal-clad cable, Type MC with ground wire where allowed to be used by Architect/Owner.

2.2 CONNECTORS AND SPLICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFC Cable Systems, Inc.
2. Gardner Bender.
3. Hubbell Power Systems, Inc.
4. Ideal Industries, Inc.
5. Ilsco; a branch of Bardes Corporation.
6. NSi Industries LLC.
7. O-Z/Gedney; a brand of the EGS Electrical Group.
8. 3M; Electrical Markets Division.
9. Tyco Electronics.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 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. Comply with NFPA 70.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; except VFC cable which shall be extra flexible stranded.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type XHHW-2, single conductors in raceway.

B. Exposed Feeders: Not acceptable. All conductors in a raceway path.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN/THWN, single conductors in raceway.

D. Exposed Branch Circuits, Including in Crawlspaces: Type THHN/THWN, single conductors in raceway.

E. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN single conductors in raceway.

F. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, and strain relief device at terminations to suit application.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

B. Complete raceway installation between conductor and cable termination points according to Section 26 0533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables according to Section 26 05 29 "Hangers and Supports for Electrical Systems."

G. Complete cable tray systems installation according to Section 26 05 36 "Cable Trays for Electrical Systems" prior to installing conductors and cables.

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than un-spliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches (300 mm) of slack.

3.5 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 26 0553 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 05 44 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 07 8413 "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

A. Testing Agency: 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. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors.

2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.

    a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
    b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
    c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

D. Test and Inspection Reports: Prepare a written report to record the following:

1. Procedures used.
2. Results that comply with requirements.
3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

E. Cables will be considered defective if they do not pass tests and inspections.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL 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 grounding and bonding systems and equipment.

B. Section includes grounding and bonding systems and equipment, plus the following special applications:

1. Underground distribution grounding.
2. Ground bonding common with lightning protection system.
3. Foundation steel electrodes.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

A. As-Built Data: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:

1. Test wells.
2. Ground rods.
3. Ground rings.
4. Grounding arrangements and connections for separately derived systems.

B. Qualification Data: For testing agency and testing agency's field supervisor.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Instructions for periodic testing and inspection of grounding features at grounding connections for separately derived systems based on NFPA 70B.
1) Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
2) Include recommended testing intervals.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

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. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Burndy; Part of Hubbell Electrical Systems.
2. Dossert; AFL Telecommunications LLC.
3. ERICO International Corporation.
4. Fushi Copperweld Inc.
5. Galvan Industries, Inc.; Electrical Products Division, LLC.
6. Harger Lightning and Grounding.
7. ILSCO.
8. O-Z/Gedney; A Brand of the EGS Electrical Group.
9. Robbins Lightning, Inc.
10. Siemens Power Transmission & Distribution, Inc.

2.2 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. Comply with UL 467 for grounding and bonding materials and equipment.

2.3 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches (6.3 by 100 mm in cross section, with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

2.4 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

D. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.5 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad sectional type; 5/8 by 96 inches (16 by 2400 mm).

B. Chemical-Enhanced Grounding Electrodes: Copper tube, straight or L-shaped, charged with nonhazardous electrolytic chemical salts.

1. Termination: Factory-attached No. 4/0 AWG bare conductor at least 48 inches (1200 mm) long.
2. Backfill Material: Electrode manufacturers recommended material.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Underground Grounding Conductors: Install bare copper conductor, No. 2/0 AWG minimum.

1. Bury at least 24 inches (600 mm) below grade.
2. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.

C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

D. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus horizontally, on insulated spacers 2 inches (50 mm) minimum from wall, 6 inches (150 mm) above finished floor unless otherwise indicated.
2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

E. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING AT THE SERVICE

A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.3 GROUNDING SEPARATELY DERIVED SYSTEMS

A. Generator: Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator.

3.4 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.

5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Metal-clad cable runs.

C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

E. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.5 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts. Building is existing and Bonding will require new straps or the utilization of existing if adequately sized.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment. Both new and existing equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

D. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes;

use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

E. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: 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. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at individual ground rods. Make tests at ground rods before any conductors are connected.
   a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
   b. Perform tests by fall-of-potential method according to IEEE 81.
4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

E. Grounding system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

G. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.

H. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL 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. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

B. Related Sections include the following:

1. Section 26 0548 "Vibration and Seismic Controls for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 ACTION SUBMITTALS

A. Product Data: For the following:

1. Steel slotted support systems.
2. Nonmetallic slotted support systems.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:

1. Trapeze hangers. Include Product Data for components.
2. Steel slotted channel systems. Include Product Data for components.
3. Nonmetallic slotted channel systems. Include Product Data for components.
4. Equipment supports.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.7 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with NFPA 70.

1.8 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete Specifications.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Available 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 Tube & Conduit.
   b. Cooper B-Line, Inc.; a division of Cooper Industries.
   c. ERICO International Corporation.
   d. GS Metals Corp.
   e. Thomas & Betts Corporation.

f. Unistrut; Tyco International, Ltd.

g. Wesanco, Inc.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.

4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.

5. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Hilti Inc.

2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.

3) MKT Fastening, LLC.

4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated **s**teel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Cooper B-Line, Inc.; a division of Cooper Industries.

2) Empire Tool and Manufacturing Co., Inc.

3) Hilti Inc.

4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.

5) MKT Fastening, LLC.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 05 50 00 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with single-bolt conduit clamps using spring friction action for retention in support channel.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
6. To Steel: Spring-tension clamps.
7. To Light Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 05 5000 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 03 3053 "Miscellaneous Cast-in-Place Concrete."

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

A. Touchup: 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 (0.05 mm).

B. Touchup: Comply with requirements in Section 099113 "Exterior Painting" and Section 09 91 23 "Interior Painting for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL 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. Metal conduits, tubing, and fittings.
2. Nonmetal conduits, tubing, and fittings.
3. Metal wireways and auxiliary gutters.
4. Nonmetal wireways and auxiliary gutters.
5. Surface raceways.
6. Boxes, enclosures, and cabinets.
7. Handholes and boxes for exterior underground cabling.

B. Related Requirements:

1. Section 26 0543 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.
2. Section 27 0528 "Pathways for Communications Systems" for conduits, wireways, surface pathways, innerduct, boxes, faceplate adapters, enclosures, cabinets, and handholes serving communications systems.
3. Section 28 0528 "Pathways for Electronic Safety and Security" for conduits, surface pathways, innerduct, boxes, and faceplate adapters serving electronic safety and security.

1.3 DEFINITIONS

A. ARC: Aluminum rigid conduit.

B. GRC: Galvanized rigid steel conduit.

C. IMC: Intermediate metal conduit.

1.4 ACTION SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.
2. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
1. Structural members in paths of conduit groups with common supports.
2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

B. Qualification Data: For professional engineer.

C. Seismic Qualification Certificates: For enclosures, cabinets, and conduit racks and their mounting provisions including those for internal 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.
4. Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.

D. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, but are not limited to, the following:
1. AFC Cable Systems, Inc.
2. Allied Tube & Conduit.
3. Anamet Electrical, Inc.
4. Electri-Flex Company.
5. O-Z/Gedney.

6. Picoma Industries.
7. Republic Conduit.
8. Robroy Industries.
9. Southwire Company.
10. Thomas & Betts Corporation.
11. Western Tube and Conduit Corporation.
12. Wheatland Tube Company.

B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. GRC: Comply with ANSI C80.1 and UL 6.

D. ARC: Comply with ANSI C80.5 and UL 6A.

E. IMC: Comply with ANSI C80.6 and UL 1242.

F. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.

1. Comply with NEMA RN 1.

2. Coating Thickness: 0.040 inch (1 mm), minimum.

G. EMT: Comply with ANSI C80.3 and UL 797.

H. FMC: Comply with UL 1; zinc-coated steel.

I. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

J. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
2. Fittings for EMT:
   a. Material: Steel.
   b. Type: Setscrew or compression.
3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.

K. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

A. Manufacturers: Subject to compliance with requirements**,** provide products by one of the following, but are not limited to, the following:

1. AFC Cable Systems, Inc.
2. Anamet Electrical, Inc.
3. Arnco Corporation.
4. CANTEX Inc.
5. CertainTeed Corporation.
6. Condux International, Inc.
7. Electri-Flex Company.
8. Kraloy.
9. Lamson & Sessions; Carlon Electrical Products.
10. Niedax-Kleinhuis USA, Inc.
11. RACO; Hubbell.
12. Thomas & Betts Corporation.

B. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. ENT: Comply with NEMA TC 13 and UL 1653.

D. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

E. LFNC: Comply with UL 1660.

F. Rigid HDPE: Comply with UL 651A.

G. Continuous HDPE: Comply with UL 651B.

H. Coilable HDPE: Preassembled with conductors or cables, and complying with ASTM D 3485.

I. RTRC: Comply with UL 1684A and NEMA TC 14.

J. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

K. Fittings for LFNC: Comply with UL 514B.

L. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

M. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers: Subject to compliance with requirements provide products by one of the following, but are not limited to, the following:

1. Cooper B-Line, Inc.
2. Hoffman.
3. Mono-Systems, Inc.
4. Square D.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.

1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Screw-cover type unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.

2.4 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, but are not limited to, the following:

1. Allied Moulded Products, Inc.
2. Hoffman.
3. Lamson & Sessions; Carlon Electrical Products.
4. Niedax-Kleinhuis USA, Inc.

B. Listing and Labeling: Nonmetallic wireways and auxiliary gutters shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Description: Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.

D. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.

E. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.

F. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

G. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.5 SURFACE RACEWAYS

A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Prime coated, ready for field painting.

1. Manufacturers: Subject to compliance with requirements provide products by one of the following, but are not limited to, the following:
   a. Mono-Systems, Inc.
   b. Panduit Corp.
   c. Wiremold / Legrand.

C. Surface Nonmetallic Raceways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, but are not limited to, the following:
   a. Hubbell Incorporated.
   b. Mono-Systems, Inc.
   c. Panduit Corp.
   d. Wiremold / Legrand.

D. Tele-Power Poles:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, but are not limited to, the following:
   a. Mono-Systems, Inc.
   b. Panduit Corp.
   c. Wiremold / Legrand.

2. Material: Galvanized steel with ivory baked-enamel finish.

3. Fittings and Accessories: Dividers, end caps, covers, cutouts, wiring harnesses, devices, mounting materials, and other fittings shall match and mate with tele-power pole as required for complete system.

2.6 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements provide products by one of the following:

1. Wiremold / Legrand
2. Adalet.
3. Cooper Technologies Company; Cooper Crouse-Hinds.
4. EGS/Appleton Electric.
5. Erickson Electrical Equipment Company.
6. FSR Inc.
7. Hoffman.
8. Hubbell Incorporated.
9. Kraloy.
10. Milbank Manufacturing Co.
11. Mono-Systems, Inc.
12. O-Z/Gedney.
13. RACO; Hubbell.
14. Robroy Industries.
15. Spring City Electrical Manufacturing Company.
16. Stahlin Non-Metallic Enclosures.
17. Thomas & Betts Corporation.

B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

F. Metal Floor Boxes:
1. Material: Cast metal.
2. Type: Fully adjustable.
3. Shape: Rectangular.
4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Nonmetallic Floor Boxes: Nonadjustable, rectangular.
1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

H. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb (23 kg). Outlet boxes designed for attachment of luminaires weighing more than 50 lb (23 kg) shall be listed and marked for the maximum allowable weight.

I. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb (32 kg).
1. Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

J. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

K. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

L. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

M. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep.

N. Gangable boxes are allowed up to a four devices.

O. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.
1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures: Fiberglass.
3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

P. Cabinets:
1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in door front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed Conduit: GRC.

2. Concealed Conduit, Aboveground: GRC, IMC, and EMT.

3. Underground Conduit: RNC, Type EPC-40-PVC, concrete encased.

4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.

5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:
1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: EMT.

3. Exposed and Subject to Severe Physical Damage: GRC. Raceway locations include the following:
   a. Loading dock.
   b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
   c. Mechanical rooms.
4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
6. Damp or Wet Locations: GRC.
7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

C. Minimum Raceway Size: 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealants recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use setscrew or compression, fittings. Comply with NEMA FB 2.10.
4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

F. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

G. Install surface raceways only where indicated on Drawings.

H. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C).

3.2 INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

B. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for hangers and supports.

E. Arrange stub-ups so curved portions of bends are not visible above finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches (300 mm) of changes in direction.

G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

H. Support conduit within 12 inches (300 mm) of enclosures to which attached.

I. Stub-ups to Above Recessed Ceilings:
   1. Use EMT, IMC, or RMC for raceways.
   2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

J. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

K. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

L. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

M. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch (35mm) trade size and insulated throat metal bushings on 1-1/2-inch (41-mm) trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

N. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

O. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

P. Cut conduit perpendicular to the length. For conduits 2-inch (53-mm) trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

Q. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

R. Surface Raceways:
   1. Install surface raceway with a minimum 2-inch (50-mm) radius control at bend points.
   2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

S. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

T. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service raceway enters a building or structure.
3. Where otherwise required by NFPA 70.

U. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

V. Expansion-Joint Fittings:
1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C) and that has straight-run length that exceeds 25 feet (7.6 m). Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F (55 deg C) and that has straight-run length that exceeds 100 feet (30 m).
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
   a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
   b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C temperature change.
   c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
   d. Attics: 135 deg F (75 deg C) temperature change.
3. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

W. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches (1830 mm) of flexible conduit for recessed and semi-recessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

X. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to top of box unless otherwise indicated.

Y. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

Z. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

AA. Locate boxes so that cover or plate will not span different building finishes.

BB. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

CC. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

DD. Set metal floor boxes level and flush with finished floor surface.

EE. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 31 20 00 "Earth Moving" for pipe less than 6 inches (150 mm) in nominal diameter.
2. Install backfill as specified in Section 31 20 00 "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."
4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete for a minimum of 12 inches (300 mm) on each side of the coupling.
    b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
6. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried conduits but a minimum of 6 inches (150 mm) below grade. Align planks along centerline of conduit.

7. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

3.4 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 05 44 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.5 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

3.6 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL 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. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Underground-line warning tape.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels.
8. Miscellaneous identification products.

1.3 ACTION SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

C. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.4 QUALITY ASSURANCE

A. Comply with ANSI A13.1 and IEEE C2.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.5 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 POWER AND CONTROL RACEWAY IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

B. Colors for Raceways Carrying Circuits at 600 V or Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage and system or service type.

C. Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing ends of legend label.

D. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

F. Tape and Stencil for Raceways Carrying Circuits More Than 600 V: 4-inch- (100-mm-) wide black stripes on 10-inch (250-mm) centers diagonally over orange background that extends full length of raceway or duct and is 12 inches (300 mm) wide. Stop stripes at legends.

G. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking cable tie fastener.

H. Write-On Tags: Polyester tag, 0.015 inch (0.38 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.2 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each cable size.

B. Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing ends of legend label.

C. Self-Adhesive, Self-Laminating Polyester Labels: Preprinted, 3-mil- (0.08-mm-) thick flexible label with acrylic pressure-sensitive adhesive that provides a clear, weather- and chemical-resistant, self-laminating, protective shield over the legend. Labels sized to fit the cable diameter such that the clear shield overlaps the entire printed legend.

D. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tube with machine-printed identification label. Sized to suit diameter of and shrinks to fit firmly around cable it identifies. Full shrink recovery at a maximum of 200 deg F (93 deg C). Comply with UL 224.

E. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking cable tie fastener.

F. Write-On Tags: Polyester tag, 0.015 inch (0.38 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
   1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
   2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

G. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of cable it identifies and to stay in place by gripping action.

H. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of cable it identifies and to stay in place by gripping action.

2.3 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.

B. Self-Adhesive, Self-Laminating Polyester Labels: Preprinted, 3-mil- (0.08-mm-) thick flexible label with acrylic pressure-sensitive adhesive that provides a clear, weather- and chemical-resistant, self-laminating, protective shield over the legend. Labels sized to fit the conductor diameter such that the clear shield overlaps the entire printed legend.

C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of conductor it identifies and to stay in place by gripping action.

D. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve with diameter sized to suit diameter of conductor it identifies and to stay in place by gripping action.

E. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tube with machine-printed identification label. Sized to suit diameter of and shrinks to fit firmly around conductor it identifies. Full shrink recovery at a maximum of 200 deg F (93 deg C). Comply with UL 224.

F. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

G. Write-On Tags: Polyester tag, 0.015 inch (0.38 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
2. Labels for Tags: Self-adhesive label, machine-printed with permanent, waterproof, black ink recommended by printer manufacturer, sized for attachment to tag.

2.4 FLOOR MARKING TAPE

A. 2-inch- (50-mm-) wide, 5-mil (0.125-mm) pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.

2.5 UNDERGROUND-LINE WARNING TAPE

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

C. Tag: Type I:

1. Pigmented polyolefin, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
2. Thickness: 4 mils (0.1 mm).
3. Weight: 18.5 lb/1000 sq. ft. (9.0 kg/100 sq. m).
4. 3-Inch (75-mm) Tensile According to ASTM D 882: 30 lbf (133.4 N), and 2500 psi (17.2 MPa).

2.6 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Baked-Enamel Warning Signs:

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch (6.4-mm) grommets in corners for mounting.
3. Nominal size, 7 by 10 inches (180 by 250 mm).

D. Metal-Backed, Butyrate Warning Signs:

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application.
2. 1/4-inch (6.4-mm) grommets in corners for mounting.
3. Nominal size, 10 by 14 inches (250 by 360 mm).

E. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."
3. Arc Flash Warnings: *Refer to specification section 260574 for Label requirements.*

2.7 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. inches (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm).

C. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.

2.8 EQUIPMENT IDENTIFICATION LABELS

A. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm).

B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.

C. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).

D. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).

E. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch (25 mm).

2.9 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: Black except where used for color-coding.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: Black.

C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, self-locking.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 7000 psi (48.2 MPa).
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).
5. Color: Black.

2.10 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

F. Attach plastic raceway and cable labels that are not self-adhesive type with clear vinyl tape with adhesive appropriate to the location and substrate.

G. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 25-foot (15-m) maximum intervals in straight runs, and at 10-foot (7.6-m) maximum intervals in congested areas.

H. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

I. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

J. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 12 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches (400 mm) overall.

K. Painted Identification: Comply with requirements in painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

A. Accessible Raceways, 600 V or Less, for Service, Feeder, and Branch Circuits 15A or More and 120V to ground: Identify with self-adhesive vinyl tape applied in bands. Install labels at 10-foot (3-m) maximum intervals.

B. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend, system voltage, and panel circuit number(s). System legends shall be as follows:
1. Emergency Power.
2. Power.
3. UPS.

C. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.

a. Color shall be factory applied.
b. Colors for 208/120-V Circuits:
1) Phase A: Black.
2) Phase B: Red.
3) Phase C: Blue.
c. Colors for 480/277-V Circuits:
1) Phase A: Brown.
2) Phase B: Orange.
3) Phase C: Yellow.
d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

D. Install instructional sign including the color code for grounded and ungrounded conductors using adhesive-film-type labels.

E. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, use self-adhesive, self-laminating polyester labels conductor or cable designation, origin, and destination.

F. Control-Circuit Conductor Termination Identification: For identification at terminations provide self-adhesive, self-laminating polyester labels with the conductor designation.

G. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.

H. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.

2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

I. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

1. Limit use of underground-line warning tape to direct-buried cables.
2. Install underground-line warning tape for both direct-buried cables and cables in raceway.

J. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

K. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Baked-enamel warning signs.

1. Comply with 29 CFR 1910.145.
2. Identify system voltage with black letters on an orange background.
3. Apply to exterior of door, cover, or other access.
4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:

    a. Power transfer switches.
    b. Controls with external control power connections.

L. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

M. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer.

N. Wiring Device Identification: For each receptacle, non-low voltage switch, or similar wiring device provide identification label.

1. Labeling Instructions: Label each device describing the panel and circuit number feeding it. Use clear white label with 3/16” high black font.

O. Identify Raceways and Exposed Cables with Color Banding: Band exposed and accessible raceways of the systems listed below for identification.
1. Bands: Pre-tensioned, snap-around, colored plastic sleeves; colored adhesive tape; or a combination of both. Make each color band 3/4 inches wide standard color tape, completely encircling conduit, and place adjacent bands of 2-color markings in contact, side by side.
2. Locate bands at changes in direction, at penetrations of walls and floors, at 20-foot maximum intervals in straight runs, and at 10 feet in congested areas.

3. Colors: As follows:

    a. 120/208 Volt – Black.
    b. 277/480 Volt – Blue.
    c. Emergency 120/208 Volt – Black and orange.
    d. Emergency 277/480 Volt – Blue and orange.
    e. Fire-Alarm System: Red.
    f. Fire-Suppression Supervisory and Control System: Red and yellow.
    g. Combined Fire-Alarm and Security System: Red and blue.
    h. Security System: Blue and yellow.
    i. Mechanical and Electrical Supervisory System: Green and blue.
    j. Data System: Green and yellow.
    k. Television Systems: Green and White.
    l. Sound/PA: Orange.
    m. Telephone: Orange and yellow.

P. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

    a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.
    b. Outdoor Equipment: Engraved, laminated acrylic or melamine label 4 inches (100 mm) high.
    c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
    d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

2. Equipment to Be Labeled: Panel 1H1 120/208V, 3-PH, 4-wire fed from panel MDR-CCT#4.

    a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be self-adhesive, engraved, laminated acrylic or melamine label.
    b. Enclosures and electrical cabinets.
    c. Access doors and panels for concealed electrical items.
    d. Switchgear.
    e. Switchboards.
    f. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
    g. Emergency system boxes and enclosures.
    h. Motor-control centers.

i. Enclosed switches.
j. Enclosed circuit breakers.
k. Enclosed controllers.
l. Variable-speed controllers.
m. Push-button stations.
n. Power transfer equipment.
o. Contactors.
p. Remote-controlled switches, dimmer modules, and control devices.
q. Battery-inverter units.
r. Battery racks.
s. Power-generating units.
t. Monitoring and control equipment.
u. UPS equipment.

END OF SECTION 260553

SECTION 260923 - LIGHTING CONTROL DEVICES

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. Time switches.
2. Photoelectric switches.
3. Standalone daylight-harvesting switching controls.
4. Indoor occupancy sensors.
5. Outdoor motion sensors.
6. Lighting contactors.
7. Emergency shunt relays.

B. Related Requirements:

1. Section 26 2726 "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show installation details for occupancy and light-level sensors.

1. Interconnection diagrams showing field-installed wiring.
2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 TIME SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of, but are not limited to, the following]:

1. Cooper Industries, Inc.
2. Intermatic, Inc.
3. Invensys Controls.
4. Leviton Mfg. Company Inc.
5. NSi Industries LLC; TORK Products.
6. Tyco Electronics; ALR Brand.

2.2 LIGHTING CONTACTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the, but are not limited to, the following:

1. Allen-Bradley/Rockwell Automation.
2. ASCO Power Technologies, LP; a division of Emerson Electric Co.
3. Eaton Corporation.
4. General Electric Company; GE Consumer & Industrial - Electrical Distribution; Total Lighting Control.
5. Square D; a brand of Schneider Electric.

B. Description: Electrically operated and electrically held, combination-type lighting contactors with fusible switch, complying with NEMA ICS 2 and UL 508.

1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
3. Enclosure: Comply with NEMA 250.
4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.

C. BAS Interface: Provide hardware interface to enable the BAS to monitor and control lighting contactors.

1. Monitoring: On-off status,
2. Control: On-off operation.

2.3 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18AWG. Comply with requirements in Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 CONTACTOR INSTALLATION

A. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.2 WIRING INSTALLATION

A. Wiring Method: Comply with Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch (13 mm).

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.3 IDENTIFICATION

A. Identify components and power and control wiring according to Section 26 0553 "Identification for Electrical Systems."

1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate lighting control devices and 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. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Lighting control devices will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control systems specified in Section 26 0943.13 "Addressable-Fixture Lighting Controls" and Section 26 0943.23 "Relay-Based Lighting Controls."

B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION 260923

SECTION 262416 - PANELBOARDS

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. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.
3. Load centers.
4. Electronic-grade panelboards.

1.3 DEFINITIONS

A. SVR: Suppressed voltage rating.

B. TVSS: Transient voltage surge suppressor.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of panelboards and overcurrent protective devices.
5. Include evidence of NRTL listing for series rating of installed devices.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
7. Include wiring diagrams for power, signal, and control wiring.
8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Seismic Qualification Certificates: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Section 26 0548 "Vibration and Seismic Controls for Electrical Systems." Include the following:

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:
1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

D. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 7823 "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

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. Keys: Two spares for each type of panelboard cabinet lock.
2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: Two spares for each panelboard.
3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

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 NEMA PB 1.

F. Comply with NFPA 70.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.10 PROJECT CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

a. Ambient Temperature: Not exceeding 23 deg F (minus 5 deg C) to plus 104 deg F (plus 40 deg C).
b. Altitude: Not exceeding project site elevation. Contractor to verify site elevation prior to ordering equipment.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Architect, Construction Manager, and Building Manager/Owner no fewer than two weeks in advance of proposed interruption of electric service.

2. Do not proceed with interruption of electric service without written permission.
3. Comply with NFPA 70E.

1.11 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.12 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Section 26 0548 "Vibration and Seismic Controls for Electrical Systems."

B. Enclosures: Flush and/or surface mounted cabinets as indicated on plans.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
b. Outdoor Locations: NEMA 250, Type 3R.
c. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
6. Finishes:

a. Panels and Trim: galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
b. Back Boxes: Galvanized steel.
c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.

7. Directory Card: Inside panelboard door, mounted in transparent card holder.

C. Incoming Mains Location: Top and/or bottom depending on installation requirements.

D. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
3. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
4. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.
5. Split Bus: Vertical buses divided into individual vertical sections.

E. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Main and Neutral Lugs: Compression type.
3. Ground Lugs and Bus-Configured Terminators: Compression type.
4. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
5. Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
6. Gutter-Tap Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
7. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

F. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

H. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Panelboards 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 and the unit will be fully operational after the seismic event.

B. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 1.

2.3 DISTRIBUTION PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of, but are not limited to, the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. Siemens Energy & Automation, Inc.
3. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

1. For doors more than 36 inches (914 mm) high, provide two latches, keyed alike.

D. Mains: Circuit breaker and/or Lugs only.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Plug-in circuit breakers.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of, but are not limited to, the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. Siemens Energy & Automation, Inc.
3. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker or lugs only.

D. Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of, but are not limited to, the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. Siemens Energy & Automation, Inc.
3. Square D; a brand of Schneider Electric.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

    a. Instantaneous trip.
    b. Long- and short-time pickup levels.
    c. Long- and short-time time adjustments.
    d. Ground-fault pickup level, time delay, and I^2t response.
4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
6. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
7. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

    a. Standard frame sizes, trip ratings, and number of poles.
    b. Lugs: Compression style, suitable for number, size, trip ratings, and conductor materials.
    c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
    d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    e. Communication Capability: Universal-mounted communication module with functions and features compatible with power monitoring and control system specified in Section 26 0913 "Electrical Power Monitoring and Control."
    f. Shunt Trip: 120V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
    g. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
    h. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
    i. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

2.6 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Equipment Mounting: Install panelboards on concrete bases, 4-inch (100-mm) nominal thickness. Comply with requirements for concrete base specified in [Section 03 3000 "Cast-in-Place Concrete."] [Section 03 3053 "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 (450-mm) centers around full perimeter of base.
2. For panelboards, 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 panelboards.
5. Attach panelboard to the vertical finished or structural surface behind the panelboard.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

D. Comply with mounting and anchoring requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

E. Mount top of trim 90 inches (2286 mm) above finished floor unless otherwise indicated.

F. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

G. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.

H. Install filler plates in unused spaces.

I. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.

J. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

K. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 26 05 53 "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Testing Agency: 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. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

E. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
    c. Instruments and Equipment:
    1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

F. Panelboards will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 26 05 73 "Overcurrent Protective Device Coordination Study."

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.

1. Measure as directed during period of normal system loading.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.6 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 262416

SECTION 262726 - WIRING DEVICES

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. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Twist-locking receptacles.
3. Receptacles with integral surge-suppression units.
4. Isolated-ground receptacles.
5. Hospital-grade receptacles.
6. Tamper-resistant receptacles.
7. Weather-resistant receptacles.
8. Snap switches and wall-box dimmers.
9. Solid-state fan speed controls.
10. Wall-switch and exterior occupancy sensors.
11. Communications outlets.
12. Pendant cord-connector devices.
13. Cord and plug sets.
14. Floor service outlets, poke-through assemblies, service poles, and multioutlet assemblies.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

D. RFI: Radio-frequency interference.

E. TVSS: Transient voltage surge suppressor.

F. UTP: Unshielded twisted pair.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Receptacles for Owner-Furnished Equipment: Match plug configurations.
2. Cord and Plug Sets: Match equipment requirements.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Samples: One for each type of device and wall plate specified, in each color specified.

1.6 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

1.8 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. Floor Service-Outlet Assemblies: One for every 10, but no less than one.
2. Poke-Through, Fire-Rated Closure Plugs: One for every five floor service outlets installed, but no fewer than two.
3. TVSS Receptacles: One for every 10 of each type installed, but no fewer than two of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Cooper Wiring Devices; Division of Cooper Industries, Inc. (Cooper).
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
3. Leviton Mfg. Company Inc. (Leviton).
4. Pass & Seymour/Legrand (Pass & Seymour).

B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
   1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
   2. Devices shall comply with the requirements in this Section.

2.3 STRAIGHT-BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

   1. Products: Subject to compliance with requirements, provide one of, but are not limited to the following:

      a. Cooper; 5351 (single), CR5362 (duplex).
      b. Hubbell; HBL5351 (single), HBL5352 (duplex).
      c. Leviton; 5891 (single), 5352 (duplex).
      d. Pass & Seymour; 5361 (single), 5362 (duplex).

   2. Description: Single-piece, rivetless, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap.

B. Isolated-Ground, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

   1. Products: Subject to compliance with requirements, provide one of, but are not limited to, the following:

      a. Cooper; IG5362RN.
      b. Hubbell; IG5362.
      c. Leviton; 5362-IG.
      d. Pass & Seymour; IG5362.

   2. Description: Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.4 GFCI RECEPTACLES

A. General Description:

1. Straight blade, feed through type.
2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

1. Products: Subject to compliance with requirements, provide one, but are not limited to, the following]:

a. Cooper; VGF20.
b. Hubbell; GFR5352L.
c. Pass & Seymour; 2095.
d. Leviton; 7590.

2.5 TOGGLE SWITCHES

A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

B. Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of, but are not limited to, the following:

a. Single Pole:
1) Cooper; AH1221.
2) Hubbell; HBL1221.
3) Leviton; 1221-2.
4) Pass & Seymour; CSB20AC1.
b. Two Pole:
1) Cooper; AH1222.
2) Hubbell; HBL1222.
3) Leviton; 1222-2.
4) Pass & Seymour; CSB20AC2.
c. Three Way:
1) Cooper; AH1223.
2) Hubbell; HBL1223.
3) Leviton; 1223-2.
4) Pass & Seymour; CSB20AC3.
d. Four Way:
1) Cooper; AH1224.
2) Hubbell; HBL1224.
3) Leviton; 1224-2.
4) Pass & Seymour; CSB20AC4.

C. Pilot-Light Switches, 20 A:

1. Products: Subject to compliance with requirements, provide one, but are not limited to, the following:
   a. Cooper; AH1221PL for 120 and 277 V.
   b. Hubbell; HBL1201PL for 120 and 277 V.
   c. Leviton; 1221-LH1.
   d. Pass & Seymour; PS20AC1RPL for 120 V, PS20AC1RPL7 for 277 V.

2. Description: Single pole, with neon-lighted handle, illuminated when switch is "off."

D. Key-Operated Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide one, but are not limited to, the following:

   a. Cooper; AH1221L.
   b. Hubbell; HBL1221L.
   c. Leviton; 1221-2L.
   d. Pass & Seymour; PS20AC1-L.

2. Description: Single pole, with factory-supplied key in lieu of switch handle.

E. Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors.
1. Products: Subject to compliance with requirements, provide one, but are not limited to, the following:

   a. Cooper; 1995.
   b. Hubbell; HBL1557.
   c. Leviton; 1257.
   d. Pass & Seymour; 1251.

F. Key-Operated, Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.

1. Products: Subject to compliance with requirements, provide one of, but are not limited to, the following:

   a. Cooper; 1995L.
   b. Hubbell; HBL1557L.
   c. Leviton; 1257L.
   d. Pass & Seymour; 1251L.

2.6 WALL-BOX DIMMERS

A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.

B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.

C. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.

1. 600 W; dimmers shall require no derating when ganged with other devices. Illuminated when "off."

D. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.7 WALL PLATES

A. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: Steel with white baked enamel, suitable for field painting
3. Material for Unfinished Spaces: Galvanized steel.
4. Material for Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, thermoplastic with lockable cover.

2.8 FLOOR SERVICE FITTINGS

A. Type: Modular, flush-type, dual-service units suitable for wiring method used.

B. Compartments: Barrier separates power from voice and data communication cabling.

C. Service Plate: Rectangular, solid brass with satin finish.

D. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.

2.9 PREFABRICATED MULTIOUTLET ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, provide products by one, but are not limited to, the following:

1. Hubbell Incorporated; Wiring Device-Kellems.
2. Wiremold/Legrand.

B. Description:

1. Two-piece surface metal raceway, with factory-wired multioutlet harness.
2. Components shall be products from single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.

C. Raceway Material: Non-Metal, with manufacturer's standard finish.

2.10 FINISHES

A. Device Color:

1. Wiring Devices Connected to Normal Power System: White unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Emergency Power System: Red.
3. TVSS Devices: Blue.
4. Isolated-Ground Receptacles: Orange.

B. Wall Plate Color: For plastic covers, match device color.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:

a. Cut back and pigtail, or replace all damaged conductors.
b. Straighten conductors that remain and remove corrosion and foreign matter.
c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.
10. Back to back devices in common walls are not permitted. Outlet boxes shall be separated by at least one stud wherever possible. In case of outlet boxes in adjacent rooms in the same stud cavity at the same height, provide a layer of expandable spray foam insulation around each box in that cavity. There must be a minimum of a 1” horizontal separation space between boxes of adjacent rooms. If this condition occurs in a fire rated wall, provide a 1 hour fire ratted putty pad to cover the back of the outlets on one side of the partition. Other junction box installation son fire rated walls shall comply with UL requirements.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the left.
2. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

A. Comply with Section 26 0553 "Identification for Electrical Systems."

B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

C. Test straight-blade for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz. (115 g).

D. Wiring device will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION 262726

SECTION 262813 - FUSES

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. Cartridge fuses rated 600-V ac and less for use in control circuits, enclosed switches, enclosed controllers, and motor-control centers.
2. Plug fuses rated 125-V ac and less for use in plug-fuse-type enclosed switches and fuseholders.
3. Plug-fuse adapters for use in Edison-base, plug-fuse sockets.
4. Spare-fuse cabinets.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:

1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.

    a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
    b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
3. Current-limitation curves for fuses with current-limiting characteristics.
4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit on translucent log-log graph paper.
5. Coordination charts and tables and related data.
6. Fuse sizes for elevator feeders and elevator disconnect switches.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 7823 "Operation and Maintenance Data," include the following:

1. Ambient temperature adjustment information.
2. Current-limitation curves for fuses with current-limiting characteristics.
3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit on translucent log-log graph paper.
4. Coordination charts and tables and related data.

1.5 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. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

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. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

E. Comply with UL 248-11 for plug fuses.

1.7 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.8 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of, but are not limited to, the following:

1. Cooper Bussmann, Inc.
2. Edison Fuse, Inc.
3. Ferraz Shawmut, Inc.
4. Littelfuse, Inc.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

2.3 PLUG FUSES

A. Characteristics: UL 248-11, nonrenewable plug fuses; 125-V ac.

2.4 PLUG-FUSE ADAPTERS

A. Characteristics: Adapters for using Type S, rejection-base plug fuses in Edison-base fuseholders or sockets; ampere ratings matching fuse ratings; irremovable once installed.

2.5 SPARE-FUSE CABINET

A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.

1. Size: Adequate for storage of spare fuses specified with 10 percent spare capacity minimum.
2. Finish: Gray, baked enamel.
3. Identification: "SPARE FUSES" in 1-1/2-inch- (38-mm-) high letters on exterior of door.
4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

A. Cartridge Fuses:

1. Other Branch Circuits: Class J, fast acting.
2. Control Circuits: Class CC, fast acting.

B. Plug Fuses:

1. Motor Branch Circuits: Edison-base type, single element time delay.
2. Other Branch Circuits: Edison-base type, dual-element time delay

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install plug-fuse adapters in Edison-base fuse holders and sockets. Ensure that adapters are irremovable once installed.

C. Install spare-fuse cabinet(s).

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 262813

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

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:

1. Fusible switches.
2. Nonfusible switches.
3. Receptacle switches.
4. Shunt trip switches.
5. Molded-case circuit breakers (MCCBs).
6. Molded-case switches.
7. Enclosures.

1.3 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 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 and the unit will be fully operational after the seismic event."

1.5 ACTION SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.

3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Include evidence of NRTL listing for series rating of installed devices.
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Submit on translucent log-log graph paper.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Seismic Qualification Certificates: For enclosed switches and circuit breakers, 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.

C. Field quality-control reports.

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

D. Manufacturer's field service report.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 7823 "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Submit on translucent log-log graph paper.

1.8 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. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
2. Fuse Pullers: Two for each size and type.

1.9 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

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 NFPA 70.

1.10 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
2. Altitude: Not exceeding this project site elevation. Contractor will verify project site altitude prior to ordering any equipment.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Architect, Construction Manager, Building manager/Owner no fewer than two weeks in advance of proposed interruption of electric service.
2. Indicate method of providing temporary electric service.
3. Do not proceed with interruption of electric service without written permission.
4. Comply with NFPA 70E.

1.11 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one, but are not limited to, the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. Siemens Energy & Automation, Inc.
3. Square D; a brand of Schneider Electric.

B. Type GD, General Duty, Single Throw, 240-V ac, 800 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with cartridge fuse interiors to accommodate specified or indicated fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

C. Type HD, Heavy Duty, Single Throw, 240 and or 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified or indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Hookstick Handle: Allows use of a hookstick to operate the handle.
5. Lugs: Compression type, suitable for number, size, and conductor material.
6. Service-Rated Switches: Labeled for use as service equipment.

2.2 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one, but are not limited to, the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. Siemens Energy & Automation, Inc.
3. Square D; a brand of Schneider Electric.

B. Type GD, General Duty, Single Throw, 600 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Hookstick Handle: Allows use of a hookstick to operate the handle.
4. Lugs: Compression type, suitable for number, size, and conductor material.

2.3 SHUNT TRIP SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one, but are not limited to, the following:

1. Cooper Bussmann, Inc.
2. Ferraz Shawmut, Inc.
3. Littelfuse, Inc.

B. General Requirements: Comply with ASME A17.1, UL 50, and UL 98, with 200-kA interrupting and short-circuit current rating when fitted with Class J fuses.

C. Switches: Three-pole, horsepower rated, with integral shunt trip mechanism and Class J fuse block; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

D. Control Circuit: 120-V ac; obtained from integral control power transformer, with primary and secondary fuses, with a control power transformer of enough capacity to operate shunt trip, connected pilot, and indicating and control devices.

E. Accessories:

1. Oiltight key switch for key-to-test function.
2. Oiltight green ON pilot light.
3. Isolated neutral lug; 200 percent rating.
4. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
5. Form C alarm contacts that change state when switch is tripped.
6. Three-pole, double-throw, fire-safety and alarm relay; 120-V ac or 24-V dc coil voltage as required by fire alarm system.
7. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.

2.4 MOLDED-CASE CIRCUIT BREAKERS

A. Manufacturers: Subject to compliance with requirements, provide products by one, but are not limited to, the following :

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. Siemens Energy & Automation, Inc.
3. Square D; a brand of Schneider Electric.

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

E. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:

1. Instantaneous trip.
2. Long- and short-time pickup levels.
3. Long- and short-time time adjustments.
4. Ground-fault pickup level, time delay, and I^2t response.

F. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

G. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.

H. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

I. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

J. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Compression type, suitable for number, size, trip ratings, and conductor material.
3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
5. Communication Capability: Universal-mounted communication module with functions and features compatible with power monitoring and control system, specified in Section 260913 "Electrical Power Monitoring and Control."
6. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.

7. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
8. Alarm Switch: One NO and one NC contact that operates only when circuit breaker has tripped.
9. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
10. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
11. Electrical Operator: Provide remote control for on, off, and reset operations.

2.5 MOLDED-CASE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one, but are not limited to, the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. Siemens Energy & Automation, Inc.
3. Square D; a brand of Schneider Electric.

B. General Requirements: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.

C. Features and Accessories:

1. Standard frame sizes and number of poles.
2. Lugs: Compression type, suitable for number, size, trip ratings, and conductor material.
3. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
5. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
6. Alarm Switch: One NO and one NC contact that operates only when switch has tripped.
7. Key Interlock Kit: Externally mounted to prohibit switch operation; key shall be removable only when switch is in off position.
8. Zone-Selective Interlocking: Integral with ground-fault shunt trip unit; for interlocking ground-fault protection function.
9. Electrical Operator: Provide remote control for on, off, and reset operations.

2.6 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Other Wet or Damp, Indoor Locations: NEMA 250, Type 3R.
3. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Comply with mounting and anchoring requirements specified in Section 26 0548 "Vibration and Seismic Controls for Electrical Systems."

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in fusible devices.

E. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Section 26 0553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: 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. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

E. Tests and Inspections:
1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

F. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 26 0573 "Overcurrent Protective Device Coordination Study."

END OF SECTION 262816

SECTION 263213 DIESEL ENGINE GENERATOR SPECIFICATION

PART 1 - GENERAL

1.1 DESCRIPTION OF SYSTEM & SITE

A. Provide a 175 kW standby power system to supply electrical power at 208/120Y Volts, 60 Hertz, _____ 3 Phase. The generator shall consist of a liquid cooled diesel engine, a synchronous AC alternator, and system controls with all necessary accessories for a complete operating system, including but not limited to the items as specified hereinafter. Basis of Design: Generac SD175

Modify the following paragraph for NEC non-ordinary locations or locations with extreme abrasive or corrosive aspects.

B. The site is an NEC ordinary location with no specific harsh environment requirements.

Engines derate with elevation and ambient. This derate is normally modest and is typically absorbed be the application's load factors. Many specifications require bidders to meet the specified kW inclusive of de-rates. This approach may result in bidders quoting the next larger model at a significant cost to the customer. Modify the following paragraph to require full output at site conditions if the applications have very tight load tolerances and significant de-rates.

C. The genset shall be applied at the listed ambient and elevation. Bidders to submit the generators rated power output at 98 ambient (˚F) and 3900 elevation (Ft).

D. Bidders are to submit the genset's sound level in dBA at 23 ft based on the configuration specified.

1.2 REQUIREMENTS OF REGULATORY AGENCIES

A. An electric generating system, consisting of a prime mover, generator, governor, coupling and all controls, must have been tested, as a complete unit, on a representative engineering prototype model of the equipment to be sold.

B. The generator set must conform to applicable NFPA requirements.

C. The generator set must be available with the Underwriters Laboratories listing (UL2200) for a stationary engine generator assembly.

D. The generator set must meet EPA federal emission guidelines for stationary standby power generation.

1.3

MANUFACTURER QUALIFICATIONS

A. This system shall be supplied by an original equipment manufacturer (OEM) who has been regularly engaged in the production of engine-alternator sets, automatic transfer switches, and associated controls for a minimum of 25 years, thereby identifying one source of supply and responsibility. Approved suppliers are Generac Industrial Power or an approved equal.

B. The manufacturer shall have printed literature and brochures describing the standard series specified, not a one of a kind fabrication.

C. Manufacturer's authorized service representative shall meet the following criteria:

1. Certified, factory trained, industrial generator technicians
2. Service support 24/7
3. Service location within 200 miles
4. Response time of 4 hours
5. Service & repair parts in-stock at performance level of 95%
6. Offer optional remote monitoring and diagnostic capabilities

1.4 SUBMITTALS

A. Engine Generator specification sheet

B. Controls specification sheet(s)

C. Installation / Layout dimensional drawing

D. Wiring schematic

E. Sound data

F. Emission certification

G. Warranty statement

PART 2 - ENGINE

2.1 ENGINE RATING AND PERFORMANCE

A. The prime mover shall be a liquid cooled, diesel fueled, turbocharged after-cooled engine of 4-cycle design. It will have adequate horsepower to achieve rated kW output with at an operating speed of 1800 RPM.

NFPA 110 versions prior to 2009 required the engine to be able to support a 100% block load. This is a typical capability of all diesel generators, though the requirement has been removed from NFPA 110.

B. The engine shall support a 100% load step.

C. The generator system shall support generator start-up and load transfer within 10 seconds.

2.2 ENGINE OIL SYSTEM

A. Full pressure lubrication shall be supplied by a positive displacement lube oil pump. The engine shall have a replaceable oil filter(s) with internal bypass and replaceable element(s).

B. The engine shall operate on mineral based oil. Synthetic oils shall not be required.

C. The oil shall be cooled by a oil cooler which is integrated into the engine system.

2.3 ENGINE COOLING SYSTEM

On unit, closed loop cooling systems are always preferred over external or non-closed loop approaches. This is due to the added complexity and potential design issues encountered with external cooling. If external cooling is implemented, the engine needs two cooling circuits: one for the engine water jacket and one for the charge-air-cooling. The engine should also be site emission verified to ensure the modification to the intake air circuit has not altered the EPA required emission performance.

A. The engine is to be cooled with a unit mounted radiator, fan, water pump, and closed coolant recovery system. The coolant system shall include a coolant fill box which will provide visual means to determine if the system has adequate coolant level. The radiator shall be designed for operation in 122 degrees F, (50 degrees C) ambient temperature.

B. The engine shall have (a) unit mounted, thermostatically controlled water jacket heater(s) to aid in quick starting. The wattage shall be as recommended by the manufacturer.

C. Engine coolant and oil drain extensions, equipped with pipe plugs and shut-off valves, must be provided to the outside of the mounting base for cleaner and more convenient engine servicing.

D. A radiator fan guard must be installed for personnel safety that meets UL and OSHA safety requirements.

2.4 ENGINE STARTING SYSTEM

A. Starting shall be by a solenoid shift, DC starting system.

B. The engine’s cranking batteries shall be lead acid. The batteries shall be sized per the manufacturer’s recommendationsThe batteries supplied shall meet NFPA 110 cranking requirements of 90 seconds of total crank time. Battery specifications (type, amp-hour rating, cold cranking amps) to be provided in the submittal.

C. The genset shall have an engine driven, battery charging alternator with integrated voltage regulation.

D. The genset shall have an automatic dual rate, float equalize, 10 amp battery charger. The charger must be protected against a reverse polarity connection. The chargers charging current shall be monitored within the generator controller to support remote monitoring and diagnostics. The battery charger is to be factory installed on the generator set. Due to line voltage drop concerns, a battery charger mounted in the transfer switch will be unacceptable.

2.5 ENGINE FUEL SYSTEM

A. The engine fuel system shall be designed for operation on #2 diesel fuel and cold weather diesel blends.

B. The engine shall include a primary fuel filter, water separator, manual fuel priming pump, and engine flexible fuel lines must be installed at the point of manufacture. Element shall be replaceable paper type.

C. The engines suction line shall be fitted with a check valve to secure prime for the engines injection pump.

2.6 ENGINE CONTROLS

A. Engines that are equipped with an electronic engine control module (ECM), shall monitor and control engine functionality and seamlessly integrate with the genset controller through digital communications. ECM monitored parameters shall be integrated into the genset controllers NFPA 110 alarm and warning requirements. All ECM fault codes shall be displayed at the genset controller in standard language – fault code numbers are not acceptable.

B. For engines without ECM functionality or for any additional genset controller monitoring, sensors are to be conditioned to a 4-20ma signal level to enhance noise immunity and all sensor connections shall be sealed to prevent corrosion.

C. Engine speed shall be controlled with an integrated isochronous governor function with no change in alternator frequency from no load to full load. Steady state regulation is to be 0.25%.

2.7 ENGINE EXHAUST & INTAKE

A. The engine exhaust emissions shall meet the EPA emission requirements for standby power generation.

B. The manufacturer shall supply its recommended stainless steel, flexible connector to couple the engine exhaust manifold to the exhaust system. A rain cap will terminate the exhaust pipe after the silencer. All components must be properly sized to assure operation without excessive back pressure when installed.

C. The manufacturer shall supply a critical grade exhaust silencer as standard. For applications with site specific sound requirements (reference section 1.1), the silencer shall be selected to achieve site sound levels.

D.

For gensets in a weather or sound attenuated enclosure, all exhaust piping from the turbo-charger discharge to the silencer shall be thermally wrapped to minimize heat dissipation inside the enclosure.

E. The engine intake air is to be filtered with engine mounted, replaceable, dry element filters.

PART 3 - ALTERNATOR

3.1 The alternator shall be the voltage and phase configuration as specified in section 1.1.1.

3.2 The alternator shall be a 4 pole, revolving field, stationary armature, synchronous machine. The excitation system shall utilize a brushless exciter with a three phase full wave rectifier assembly protected against abnormal transient conditions by a surge protector. Photo-sensitive components will not be permitted in the rotating exciter.

3.3 The alternator shall include a permanent magnet generator (PMG) for excitation support. The system shall supply a minimum short circuit support current of 300% of the rating (250% for 50Hz operation) for 10 seconds.

The following statement ensures that the alternator has enough transient capacity to support application motor starting while maintaining acceptable voltage dips. Across the line starting motors require skVA = 6 x Hp. Acceptable voltage dips for general applications tend to be 15%. For dedicated motor starting applications (assuming NEMA motor starters) voltage dips of 30 to 35% are common. Note that starting large motors across the line while supporting small voltage dips often requires significant alternator & genset upsizing.

3.4 The alternator shall support 38 skVA with a maximum voltage dip of 35%.

3.5 Three phase alternators shall be 12 lead, broad range capable of supporting voltage reconnection. Single phase alternators shall be four lead and dedicated voltage designs (600v) shall be six lead. All leads must be extended into a NEMA 1 connection box for easy termination. A fully rated, isolated neutral connection must be included by the generator set manufacturer.

3.6 The alternator shall use a single, sealed bearing design. The rotor shall be connected to the engine flywheel using flexible drive disks. The stator shall be direct connected to the engine to ensure permanent alignment.

Utilizing high temperature insulation materials with a low temperature alternator design ensures application flexibility. Powering non-linear loads and load imbalances cause addition alternator heating.

3.7 The alternator shall meet temperature rise standards of UL2200 (120 degrees C). The insulation system material shall be class "H" capable of withstanding 150 degrees C temperature rise.

The circuit breaker on the alternator is designed to protect the cabling, not the alternator. The alternator's thermal damage curve does not coordinate with the standard alternator circuit breaker. The functionality below provides full protection against all overload and short circuit conditions.

3.8 The alternator shall be protected against overloads and short circuit conditions by advanced control panel protective functions. The control panel is to provide a time current algorithm that protects the alternator against short circuits. To ensure precision protection and repeatable trip characteristics, these functions must be implemented electronically in the generator control panel -- thermal magnetic breaker implementation are not acceptable.

The following items are designed to enhance the alternator's ability to withstand moisture impregnation that is inherent in standby operation. These items should be include for any humid environments.

3.9 An alternator strip heater shall be installed to prevent moisture condensation from forming on the alternator windings. A tropical coating shall also be applied to the alternator windings to provide additional protection against the entrance of moisture.

PART 4 - CONTROLS

4.1 The generator control system shall be a fully integrated microprocessor based control system for standby emergency engine generators meeting all requirements of NFPA 110 level 1.

4.2 The generator control system shall be a fully integrated control system enabling remote diagnostics and easy building management integration of all generator functions. The generator controller shall provide integrated and digital control over all generator functions including: engine protection, alternator protection, speed governing, voltage regulation and all related generator operations. The generator controller must also provide seamless digital integration with the engine's electronic engine control module (ECM) if so equipped. Generator controller's that utilize separate voltage regulators and speed governors or do not provide seamless integration with the engine management system are considered less desirable.

4.3 Communications shall be supported with building automation via the Modbus protocol without network cards. Optional internet and intranet connectivity shall be available.

4.4 The control system shall provide an environmentally sealed design including encapsulated circuit boards and sealed automotive style plugs for all sensors and circuit board connections. The use of non-encapsulated boards, edge cards, and pc ribbon cable connections are considered unacceptable.

4.5 Circuit boards shall utilize surface mount technology to provide vibration durability. Circuit boards that utilize large capacitors or heat sinks must utilize encapsulation methods to securely support these components.

4.6 A predictive maintenance algorithm that alarms when maintenance is required. The controller shall have the capability to call out to the local servicing dealer when maintenance is required.

Diagnostic capabilities are critical to minimize mean time to repair (MTTR). Time stamped alarms and event logs are essential to perform diagnostic recreation of cascading events. Strip chart (data logging & graphing) capability is essential in evaluating genset performance.

4.7 Diagnostic capabilities should include time-stamped event and alarm logs, ability to capture operational parameters during events, simultaneous monitoring of all input or output parameters, callout capabilities, support for multi-channel digital strip chart functionality and .2 msec data logging capabilities.

System level protection is critical to any power system. Instantaneous and steady state protective trip points are essential to creating system level protection. Without this functionality, under-voltage protection may need to be set low to accommodate a motor start and then provide no protection to a steady state “brown-out” under-voltage condition.

4.8 In addition to standard NFPA 110 alarms, the application loads should also be protected through instantaneous and steady state protective settings on system voltage, frequency, and power levels.

4.9 The control system shall provide pre-wired customer use I/O: 4 relay outputs (user definable functions), 4 contact inputs, 2 analog inputs, communications support via RS232, RS485, or an optional modem. Additional I/O must be an available option.

4.10 Customer I/O shall be software configurable providing full access to all alarm, event, data logging, and shutdown functionality. In addition, custom ladder logic functionality inside the generator controller shall be supported to provide application support flexibility. The ladder logic function shall have access to all the controller inputs and customer assignable outputs.

4.11 The control panel shall include a digital display for all user pertinent unit parameters including: engine and alternator operating conditions; oil pressure and optional oil temperature; coolant temperature and level alarm; fuel level (where applicable); engine speed; DC battery voltage; run time hours; generator voltages, amps, frequency, kilowatts, and power factor; alarm status and current alarm(s) condition per NFPA 110 level 1.

PART 5 -

ENGINE / ALTERNATOR PACKAGING

5.1 The engine/alternator shall be bolted directly to the genset frame and the entire frame shall be mounted on spring isolators. The engine/alternator shall be isolated from the generator frame with rubber isolators. The packaging shall not require the addition of external spring isolators.

5.2 A mainline, thermal magneticcircuit breaker carrying the UL mark shall be factory installed. The breaker shall be rated 600A. The line side connections are to be made at the factory. Output lugs shall be provided for load side connections.

5.3 ENCLOSURE

A. The genset shall be packaged with a sound attenuating enclosure.

B. The enclosure shall be made of steel with a minimum thickness of 14 gauge. The enclosure is to have hinged, removable doors to allow access to the engine, alternator and control panel. The hinges shall allow for door fit adjustment. Hinges and all exposed fasteners will be stainless steel or JS5000. The use of pop-rivets weakens the paint system and not allowed on external painted surfaces. Each door will have lockable hardware with identical keys.

C. The enclosure shall be coated with electrostatic applied powder paint, baked and finished to manufacturer's specifications. The color will be manufacturer’s standard.

D. The sound attenuated enclosure shall utilize an upward discharging radiator hood. The enclosure shall be completely lined with sound deadening material. This material must be of a self extinguishing design.

E. The genset silencer shall be mounted on the top of the enclosure. Due to architectural concerns, an optional upgrade price shall be provided for placing a thermally wrapped silencer inside the enclosure.

5.4 SUB-BASE FUEL TANK

A. The packaging shall include a double wall, sub-base mounted, UL142 listed fuel tank. The tank shall be sized to provide 24 hours of run time.

B. The tank shall include fuel suction and return connections, normal and emergency vents, secondary containment emergency vent and rupture basin sensor, mechanical fuel level indication and a stub-up area convenient for electrical conduit entry.

C. The fuel tank shall use an electric fuel sensor to provide an analog indication of fuel level. The controller shall have a warning indication on low fuel level and provide optional shutdown functionality for low, low fuel level.

D. For applications 500 kW and larger, the fuel tank shall have a built-in catch basin to secure genset coolant and oil against an accidental spills.

E. The fuel tank must be supplied by the engine-generator set manufacturer and be installed before

shipment.

PART 6 - LOOSE ITEMS

6.1 Supplier to itemize loose parts that require site mounting and installation. Preference will be shown for gensets that factory mount items like mufflers, battery chargers, etc.

6.2 SPARE PARTS:

A. Fuses: One spare set

B. Filters One spare set (air, fuel, oil)

PART 7 - ADDITIONAL PROJECT REQUIREMENTS

7.1 FACTORY TESTING

A. Before shipment of the equipment, the engine-generator set shall be tested under rated load for performance and proper functioning of control and interfacing circuits. Tests shall include:

1. Verify voltage & frequency stability.

2. Verify transient voltage & frequency dip response.

3. Load test the generator for 2 hours.

7.2 OWNER'S MANUALS

A. Three (3) sets of owner's manuals specific to the product supplied must accompany delivery of the equipment. General operating instruction, preventive maintenance, wiring diagrams, schematics and parts exploded views specific to this model must be included.

7.3 INSTALLATION

A. Contractor shall install the complete electrical generating system including all external fuel connections in accordance with requirements of NEC, NFPA, and the manufacturer's recommendations as reviewed by the Engineer.

7.4 SERVICE

A. Supplier of the genset and associated items shall have permanent service facilities in this trade area. These facilities shall comprise a permanent force of EGSA certified and factory trained service personnel on 24 hour call, experienced in servicing this type of equipment, providing

warranty and routine maintenance service to afford the owner maximum protection. Delegation of this service responsibility for any of the equipment listed herein will not be considered fulfillment of these specifications. Service contracts shall also be available.

7.4 WARRANTY

A. The standby electric generating system components, complete genset and instrumentation panel shall be warranted by the manufacturer against defective materials and factory workmanship for a period of five (5) years. Such defective parts shall be repaired or replaced at the manufacturer's option, free of charge for parts, labor and travel.

B. The warranty period shall commence when the standby power system is first placed into service. Multiple warranties for individual components (engine, alternator, controls, etc.) will not be acceptable. Satisfactory warranty documents must be provided. Also, in the judgment of the specifying authority, the manufacturer supplying the warranty for the complete system must have the necessary financial strength and technical expertise with all components supplied to provide adequate warranty support.

7.5 STARTUP AND CHECKOUT

A. The supplier of the electric generating plant and associated items covered herein shall provide factory trained technicians to checkout the completed installation and to perform an initial startup inspection to include:

1. Ensuring the engine starts (both hot and cold) within the specified time.
2. Verification of engine parameters within specification.
3. Verify no load frequency and voltage, adjusting if required.
4. Test all automatic shutdowns of the engine-generator.
5. Perform a load test of the electric plant, ensuring full load frequency and voltage are within specification by using building load.

7.6 TRAINING

A. Training is to be supplied by the start-up technician during commissioning. The training should cover basic generator operation and common generator issues that can be managed by the end-user.

END OF SECTION 263213

SECTION 263600 – TRANSFER SWITCHES

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 SCOPE

A. Furnish and install the low voltage automatic transfer switches having the ratings, features/accessories and enclosures as specified herein and as shown on the contract drawings.

1.3 REFERENCES

A. The automatic transfer switches and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of UL and NEMA as follows:

1. UL 1008 – Transfer Switches
2. UL 991 - Tests for Safety-Related Controls Employing Solid-State Devices
3. NFPA 70 – National Electrical Code
4. NFPA 99 – Essential Electrical Systems of Health Care Facilities
5. NFPA 110 – Emergency and Standby Power Systems
6. NEMA ICS 10 – AC Transfer Switch Equipment
7. IEEE 446 – Recommended Practice for Emergency and Standby Power Systems

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.

1. Technical data on all major components of all transfer switches and other products described in this section. Data is required for the transfer switch mechanism, control system, cabinet, and protective devices specifically listed for use with each transfer switch. Include stead stated and fault current ratings weights, operating characteristics and furnished specialties and accessories. The following information shall be submitted to the Engineer for each switch specified:

    a. Dimensioned outline drawings of assembly, including elevations, sections, and details including minimal clearances, conductor entry provisions, gutter space, installed features and devices and material lists for each switch specified.
    b. Schematic diagram and internal electrical wiring drawings
    c. Conduit space locations within the assembly
    d. Assembly ratings including:

1. Withstand and Closing rating
2. Voltage
3. Continuous current rating
4. Short-Time rating if applicable
5. Short-circuit rating if ordered with integral protection

e. Cable terminal sizes
f. Product Specification Sheets
g. Installation and mounting instructions, including information for proper installation of equipment to meet seismic requirements.

B. Manufacturer Seismic Qualification Certification: Submit certification that transfer switches accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:

1. Seismic certification, as required for site conditions. Seismic certifications shall be third-party certified, and based on testing. Certification based on calculations does not meet this requirement.
2. 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 and the unit will be fully operational after the seismic event."
3. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
4. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.5 INFORMATIONALSUBMITTALS

A. Manufacturer and Supplier Qualification Data

1. The transfer switch manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

a. The manufacturer of this equipment shall have produced similar equipment for a minimum period of 10 years.
b. Operation and Maintenance Data: For each switch to include in operation and maintenance manuals.
c. Warranty documents demonstrating compliance with the project’s contract requirements.

1.6 QUALITY ASSURANCE

A. Only approved bidders shall supply equipment provided under this contract.

1. Manufacturer Qualifications: The equipment supplier shall maintain a service center capable of providing training, parts, maintenance and emergency repairs to equipment,

including transfer switch, generator sets and remote monitoring equipment (if applicable) at the site within a response period of less than (eight hours or appropriate time period designated for Project) from time of notification.

2. The transfer switch shall be serviced by technicians employed by, and specially trained and certified by, the generator set supplier and the supplier shall have a service organization that is factory-certified in both generator set and transfer switch service.
3. The manufacturer shall maintain model and serial number records of each transfer switch provided for at least 10 years.
4. Source Limitations: Transfer switch and Generator are to be obtained through one source from a single manufacturer. The generator set manufacturer shall warrant transfer switches to provide a single source of responsibility for products provided.
5. 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 as suitable for use in emergency, legally required or optional standby use as appropriate for the connected load.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Generac Power Systems

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if pre-approved by the engineer ten (10) days prior to bid date.

2.2 CONSTRUCTION

A. Switching devices for 100 Amp through 1000 Amp transfer switches shall be molded case switch type. All breaker transfer switches shall be UL listed for application in their intended enclosures for 100% of their continuous ampere rating.

B. The automatic transfer switch shall be of double throw construction operated by a reliable electrical mechanism momentarily energized.

C. Each transfer switch shall be positively interlocked both mechanically and electrically to prevent simultaneous closing of both sources under either automatic or manual operation.

D. Main contacts shall be silver composition and mechanically held in both normal and emergency positions.

E. Switches shall operate delayed transition, with a time delay in the neutral position adjustable from 0 to 120 seconds

F. The switching panel shall consist of completely enclosed contact assemblies and a separate control or transformer panel. Control power for all transfer operations shall be derived from the

line side of the source to which the load is being transferred. The transformer shall be multi-tap for ease of voltage adjustment in the field.

G. Transfer switches shall be capable of being operated manually under full rated load conditions. Manual operation shall be accomplished by a permanently attached manual operator, or by integrally mounted pushbuttons. Removable manual operating handles, and handles that may move in the event of an electrical operation during the manual operation, are not acceptable. Manual operators requiring source or load disconnection prior to manual operation are not acceptable.

H. On transfer switches requiring a fourth pole for switching the neutral, the neutral shall be identical to the other power poles. Switched neutral poles which are add-on or overlap, or that are not capable of breaking full rated load current are not acceptable.

I. On transfer switches requiring a solid neutral, the neutral shall be fully rated.

2.3 MICROPROCESSOR LOGIC

A. The controller shall be hardened against potential problems from transients and surges. Operation of the transfer switch and monitoring of both sources shall be managed by the controller.

B. The automatic transfer switch controllers shall meet or exceed the following standards in addition to the basic switch standards:

1. IEC 61000-4-2 - EMC Testing and Measurement Techniques - Electrostatic Discharge Immunity Test
2. IEC 61000-4-3 - EMC Testing and Measurement Techniques - Radio-frequency, Electromagnetic Field Immunity Test
3. IEC 61000-4-4 - EMC Testing and Measurement Techniques - Electrical Fast Transient/Burst Immunity Test
4. IEC 61000-4-5 - EMC Testing and Measurement Techniques - Surge Immunity Test
5. IEC 61000-4-6 - EMC Testing and Measurement Techniques - Immunity to Conducted Disturbances, Induced by Radio-frequency Fields
6. IEC 61000-4-11 - EMC Testing and Measurement Techniques - Voltage Dips, Short Interrupts and Voltage Variations Immunity Tests
7. CISPR11, Class B - Industrial, Scientific and Medical Radio-frequency Equipment - Electromagnetic Disturbance Characteristics - Limits and Methods of Measurement
8. FCC Part 15, Subpart B, Class B

2.4 ENCLOSURE

A. Each transfer switch shall be provided in a NEMA 3R enclosure suitable for use in environments indicated in the drawings.

B. NEMA 3R enclosures shall be painted with the manufacturer’s standard light gray ANSI 61paint.

2.5 CONTROLLER DISPLAY AND KEYPAD

A. The microprocessor-based controller display shall be UV resistant and include Color TFT, backlit display. The controller shall be capable of displaying transfer switch status, parameters, and diagnostic data. All set point parameters shall be password protected and programmable using the controller keypad, USB port, or remotely using serial port access. Limited abbreviations or codes shall be used for transfer switch functions.

B. The microprocessor-based controller shall include a mimic bus display consisting of six (6) individual LED's for indicating the following:

1. Availability status of source 1
2. Availability status of source 2
3. Connection status of source 1
4. Connection status of source 2
5. Source 1 Preferred
6. Source 2 Preferred

2.6 VOLTAGE AND FREQUENCY SENSING

A. The controller shall have a voltage range of 0-790 volts (50/60 Hz) with an accuracy of +/- 1% of the reading and a frequency range of 40-70 Hz with an accuracy of +/- .3 Hz.

B. Voltage and frequency dropout and pickup parameters are set as a percentage of the nominal voltage as indicated in the table below.

Setpoint	Sources	Dropout	Pickup
Undervoltage	Source1 and 2	70 – 97%	(DO + 2%) - 99%
Overvoltage	Source 1 and 2	105 – 110%	103% - (DO – 2%)
Underfrequency	Source 1 and 2	90 – 97%	(DO + 1Hz) – 99%
Overfrequency	Source 1 and 2	103 – 105%	101% - (DO – 1Hz)
Voltage Unbalance	Source 1 and 2	5 – 20%	(UNBAL DO% - 2) – 3%

C. The normal and emergency sources shall include phase reversal protection. The preferred rotation is programmable as ABC or CBA.

2.7 TIME DELAYS

A. A time delay shall be provided on transfer to source 2, adjustable from 0 to 166 minutes.

B. A time delay shall be provided to override a momentary power outage or voltage fluctuation, adjustable from 0 to 120 seconds.

C. A time delay shall be provided on retransfer from source 2 to source 1, adjustable from 0 to 166 minutes.

D. A time delay shall be provided after retransfer that allows the generator to run unloaded prior to shutdown, adjustable form 0 to 166 minutes.

E. A time delay shall be provided for engine failure to start, adjustable 0- 6 seconds.

F. A pre and or post transfer time delay output adjustable from 0-120 seconds. The contact shall be a form-c contact rated for 10-Amp at 250-Vac and 10-Amp at 30-Vdc.

G. All delays shall be field adjustable from the microprocessor-based controller without the use of special tools.

2.8 ADDITIONAL FEATURES

A. The controller shall include two independently programmable Engine Exercisers, selectable as disabled, 7, 14, or 28 day interval, or by calendar date. Run time shall be adjustable for 0-600 minutes, with or without load. Upon loss of source 2 power, the ATS shall automatically return to source 1. Transfer time delays shall also be independently programmable for test events.

B. The controller shall include a keypad pushbutton to initiate a system test.

C. The controller shall include 4 user configurable inputs. Each input provides 50 volts at 10ma and can be user configured to one of the following features:

1. Input to accept a remote contact which closes to initiate a transfer to source 2. This feature shall be failsafe and an automatic retransfer shall occur in the event that source 2 power is lost.
2. Input to accept a remote contact which closes to initiate a transfer to source 2. This feature shall be failsafe and an automatic retransfer shall occur in the event that source 2 power is lost.
3. Input to accept a remote contact which opens to inhibit transfer to source 2.
4. Input to enable monitor mode to disable automatic operation of the transfer switch while continuing to display status. Monitor mode allows set point programming at the controller display.
5. Input to enable lockout feature to disable automatic operations of the transfer switch following an overcurrent trip of an integral circuit breaker.
6. Input to enable or disable manual retransfer to source 1.
7. Input to initiate manual retransfer to source 1.
8. Input to initiate a remote engine test. The test will run using the programmed engine test set points.
9. Input to select source 1 or source 2 as the preferred source.
10. Input to initiate a remote load test.
11. Input to indicate the bypass transfer switch is closed on a source.
12. Input to bypass time delays
13. Input to receive engine start signal from a master controller in a three source application.

D. The controller shall include 4 user configurable outputs rated for 10-Amp at 250-Vac and 10-Amp at 30-Vdc. Each input can be user configured to one of the following features:

1. Source 1 connected
2. Source 2 connected
3. ATS in test
4. ATS not in automatic mode (Monitor Mode)
5. General Alarm indication for failure to transfer, mechanical fault, or electrical fault.
6. Engine Test Aborted
7. Engine cool down in process
8. Engine start contact status
9. Emergency inhibit on
10. Load sequence – Output used to signal select loads to disconnect prior to transfer and reconnect 0-120 seconds after. Loads are reconnected sequentially.
11. Selective load shed – Output used to shed low priority loads when the load reaches a programmed threshold value. A load shed and load restore set point (measured in kW) are associated with this feature.
12. Load bank control – Output to disconnect a load bank during an engine run test if a transfer to a source 2 generator is required.
13. Pre and/or post transfer signal - A pre and or post transfer time delay output adjustable from 0-120 seconds.

E. One Form C auxiliary contact to indicate Source 1 position and one Form C contact to indicate source 2 position. The contacts shall be rated for 10-Amp, 1/3-Horsepower at 250-Vac and 10-Amp at 30-Vdc.

F. One Form C contact for Source 1 Available. The contacts shall be rated for 10-Amp, 1/3-Horsepower at 250-Vac and 10-Amp at 30-Vdc.

G. One Form C contact for Source 2 Available. The contacts shall be rated for 10-Amp, 1/3-Horsepower at 250-Vac and 10-Amp at 30-Vdc.

H. Data Logging

1. Historical Data Storage to include:

a. Engine Run Time
b. Source 1 Available time
c. Source 2 Available time
d. Source 1 Connected time
e. Source 2 Connected time
f. Source 1 Engine Run Time
g. Source 2 Engine Run Time
h. Load Energized Time
i. Number of Transfers

2. Event Summary shall include up to 100 date and time stamped events. All metered values are logged for each event. Event summaries include:

    a. Transfer events
    b. Alarms
    c. Changes to the set points
    d. Changes to the time/date
    e. Resetting a historical counter
    f. Engine Run test

3. Event Details shall include up to 350 date and time stamped events. All metered values are logged for each event. Event details include detailed sequence of operations of a transfer event.
4. Event recording shall capture 4 seconds of metered data, stored every 20 msec for certain events. The data is captured 2 seconds before and 2 seconds after the event. Oscillographic data for 10 events is stored and may be downloaded over USB. Events Include:

    a. Source unavailability actions that initiate a transfer sequence (Undervoltage, Overvoltage, etc.)
    b. Successful transfers (at the point of breaker/contactor closure)
    c. Unsuccessful transfers (at the point of breaker/contactor failure to close or open)

2.9 OPTIONAL ACCESSORIES

A. Integrated Load Metering – The controller shall include integral load metering. When included, metered values shall be viewable from the controller LCD display.

1. Source 1 Voltages (3Φ)
2. Source 2 Voltages (3Φ)
3. Load Voltages (3Φ)
4. Source 1 Frequency
5. Source 2 Frequency
6. Load Frequency
7. Load Currents (3Φ)
8. Load kW
9. Load kVar
10. Load kVA
11. pF

B. Remote Annunciator and Controller:

1. Monitor up to eight (8) automatic transfer switches.

    a. 7” touchscreen color display
    b. Mimic bus display for each transfer switch with indication of source availability, based on controller pickup and dropout settings, and switch position.
    c. Each mimic bus display shall be marked with the designation of the transfer switch monitored.
    d. Indication of switch in test mode, .

e. Indication of failure of digital communication link.

2. Control Functions

a. Control functions shall be password protected and shall include:

1. Initiate engine test.
2. Initiate a failsafe transfer to source 2.
3. Initiate manual retransfer.

3. Indicating Lights: Grouped for each transfer switch monitored.
4. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.
5. Mounting: Flush, modular, steel cabinet, unless otherwise indicated.
6. Communications capability to be compatible with ATS controller.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Floor-Mounting Switch: Anchor to floor by bolting.

Concrete Bases: 4 inches (100 mm) high, reinforced, with chamfered edges. Extend base no more than 4 inches (100 mm) in all directions beyond the maximum dimensions of switch, unless otherwise indicated or unless required for seismic support. Construct concrete bases according to Division 26 Section "Hangers and Supports for Electrical Systems."

B. Annunciator and Control Panel Mounting: Flush in wall, unless otherwise indicated.

C. Identify components according to Division 26 Section "Identification for Electrical Systems."

D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.2 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

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 tests and inspections in conjunction with factory-authorized service representative:

1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.

2. Perform each visual and mechanical inspection and electrical testing as outlined below:

   a. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

      1. Check for electrical continuity of circuits and for short circuits.
      2. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
      3. Verify that manual transfer warnings are properly placed.
      4. Perform manual transfer operation.

3. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.

   a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.

   b. Simulate loss of phase-to-ground voltage for each phase of normal source.

   c. Verify time-delay settings.

   d. Verify pickup and dropout voltages by data readout or inspection of control settings.

   e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.

   f. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

   4. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.

      1. Verify grounding connections and locations and ratings of sensors.

   5. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.

1. Verify grounding connections and locations and ratings of sensors.

   Observe reaction of circuit-interrupting devices when simulated fault current is applied at sensors.

B. Coordinate tests with tests of generator and run them concurrently.

C. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

D. Remove and replace malfunctioning units and retest as specified above.

3.4 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Division 17 Section "Demonstration and Training."

END OF SECTION 263600

SECTION 264313 - SURGE PROTECTION DEVICES

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 field-mounted (installed external to electrical equipment) SPDs for low-voltage (120 to 600 V) power distribution and control equipment.

B. The SPD shall provide TOV protection in addition to surge protection.

C. The requirements of this specification section supersede those in other specification sections.

1.3 DEFINITIONS

A. Inominal: Nominal discharge current.

B. MCOV: Maximum continuous operating voltage.

C. Mode(s), also Modes of Protection: The pair of electrical connections where the VPR applies.

D. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.

E. OCPD: Overcurrent protective device.

F. SCCR: Short-circuit current rating.

G. SPD: Surge protective device.

H. TOV: Temporary overvoltage.

I. VPR: Voltage protection rating.

1.4 ACTION SUBMITTALS

A. Products will only be considered for approval if the request is accompanied with the appropriate SPD SPECIFIED PERFORMANCE COMPLIANCE FORM attachment(s) at the conclusion of this specification, fully executed with the required supporting documentation and signed by an authorized company representative. For any approval request to be considered complete, the required supporting documentation shall be provided for each model to be supplied.

B. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
2. Copy of UL Category Code VZCA certification, as a minimum, listing the tested values for VPRs, Inominal ratings, MCOVs, type designations, OCPD requirements, model numbers, system voltages, and modes of protection.

C. Documentation of Performance

1. Provide a copy of peak surge current test report, certifying that the SPD has been tested to, and survives, the peak surge current rating as specified.
2. Provide a copy of repetitive impulse test report, certifying that the SPD has been tested to, and survives, the number of repetitive impulses as specified.
3. Provide a copy of TOV performance testing.

D. Method and Equipment to be Used for Installed Testing (For Spec Section 3.2)

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranty. For manufacturer’s special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For SPDs to include in maintenance manuals.

B. Copy of installed test report.

1.7 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace SPDs that fail in materials or workmanship within specified warranty period.

1. Warranty period: Twenty (20) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL SPD REQUIREMENTS

A. SPD and Accessories. Listed and labeled as defined by NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

C. Comply with UL 1449.

D. MCOV of the SPD shall be the nominal system voltage.

2.2 SERVICE ENTRANCE SUPPRESSOR

A. Manufacturer: Subject to compliance with requirements, provide product by one of the following:

1. Current Technology SL3 Series (Basis of Design).

2. Engineer Approved Equal.
   a. Other manufacturers wishing to have specific products evaluated for equivalence shall provide ATTACHMENT 1 – SERVICE ENTRANCE SPD SPECIFIED PERFORMANCE COMPLIANCE FORM, fully executed with the required documentation, and signed by an authorized company representative, to demonstrate compliance with the performance requirements of this specification, no less than 10 days prior to the bid date.
   b. Failure to provide the required documentation, for each model to be supplied, no less than 10 days prior to the bid date will disqualify products from consideration for this project.

B. SPDs: Comply with UL 1449 3rd Edition, Type 1.

1. SPDs with the following features and accessories.
   a. Mounted external to electrical equipment.
   b. Integral disconnect switch, where indicated on the drawings.
   c. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
   d. SPD monitoring shall include:
      1.) Indicator lights which display protection status.
      2.) Audible alarm with silence switch.
      3.) Form C contacts rated at 5 A and 250 V, one normally open and one normally closed for remote monitoring of protection status.
      4.) Component tracking and visual indication of percent protection remaining.
      5.) Surge counter which measures, discriminates between and indicates the level of surges.
         a.) Low level surge: 100 A to 500 A
         b.) Medium level surge: 500 A to 3000A.
         c.) High level surge: > 3000 A.
      6.) Time/date stamp, duration and magnitude of the following events:
         a.) Sag
         b.) Swell
         c.) Voltage drop-outs
         d.) Power outages

e.) THD
f.) Frequency excursions
g.) Volts (RMS, per phase)

e. Information from monitoring shall be available through the facility network.

1.) Via ModBus.
2.) Via Ethernet.

f. Integral Test Point with test data from factory provided for comparison. Information is provided in the form of suppressed voltage rating given by portable test set and written on a Diagnostic Signature Card which will be provided with the device. See section 3.2.

C. Comply with UL 1283.

D. Performance Ratings

1. Peak Surge Current Rating

a. The peak surge current withstand rating per mode shall be as indicated in the table below, for the respective Service Entrance current rating.
b. The peak surge current rating shall the surge current at which the SPD was tested and which the SPD survived—with less than a 10% degradation in VPR. Testing documentation shall be provided. (Due to present industry testing limitations, surge currents ratings greater than 200 kA will be tested at 200 kA.)
c. Peak surge current ratings which are the arithmetic sum of the ratings of individual MOVs in a given mode are not acceptable.

2. Repetitive Impulse Rating

a. The minimum repetitive impulse capacity (10 kA and 20 kV) of the SPD per mode shall not be less than as indicated in the table below, for the respective Service Entrance current rating.
b. The minimum repetitive impulse capacity shall be the number of impulses at which the SPD was tested and which the SPD survived—with less than a 10% degradation in VPR. Testing documentation shall be provided.
c. Minimum repetitive ratings which are derived by calculations are not acceptable.

Product Application and Performance Rating Chart						
Service Entrance Current Rating	Surge Current Rating per Mode		Surge Current Rating per Phase		Repetitive Impulse Rating per Mode	
	Single Service Entrance	Multiple Service Entrances*	Single Service Entrance	Multiple Service Entrances*	Single Service Entrance	Multiple Service Entrances*
3000 A (and above)	300 kA	200 kA	600 kA	400 kA	17,000	15,000
2500 A	250 kA	200 kA	500 kA	400 kA	16,000	15,000
2000 A	200 kA	150 kA	400 kA	300 kA	15,000	14,500
1600 A	150 kA	125 kA	300 kA	250 kA	14,500	14,000
1000 A - 1200 A	125 kA	125 kA	250 kA	250 kA	14,000	14,000
800 A	100 kA	80 kA	200 kA	160 kA	14,000	12,000
400 A - 600 A	80 kA	50 kA	160 kA	100 kA	12,000	10,000
200 A	50 kA	50 kA	100 kA	100 kA	10,000	10,000

*Multiple Service Entrances to be understood as one feed from a utility substation feeding multiple (i.e., more than one) utility transformers and/or utility meters for their respective Service Entrance sections.

3. Overvoltage Performance

   a. The SPD shall be able to prevent common temporary overvoltages and high impedance faults from damaging the MOVs, increasing their longevity and ability to protect the critical load.

   b. For limited and intermediate current TOVs (as specified in UL 1449 article 39.3 and 39.4) of 30 cycles, the voltage to the MOVs shall be reduced from 173% of nominal voltage, at the intermediate currents listed to the values below.

      1.) 30 A: 140%

      2.) 100 A: 150%

      3.) 500 A: 160%

      4.) 1000 A: 160%

   c. The SPD shall be able to withstand multiple TOVs without damage to the MOVs by shunting current away from the MOVs during the overvoltage. SPD must have the ability to withstand greater than 100 TOVs with a source current of 30A, duration of 30 cycles, with 10 seconds between TOV events. Testing documentation shall be provided.

E. Protection modes and UL 1449 VPR for the applicable modes of grounded WYE/delta and high leg delta circuits shall not exceed the following.

1. For 480Y/277 V and 480 V delta systems:
   a. Line to Neutral: 1200 V
   b. Line to Ground: 1200 V
   c. Neutral to Ground: 1000 V
   d. Line to Line: 2000 V

2. For 208Y/120 V and 208 V delta systems:
   a. Line to Neutral: 700 V
   b. Line to Ground: 700 V
   c. Neutral to Ground: 700 V
   d. Line-to-Line 1200 V

F. SCCR: Equal to or exceed 200 kA.

G. Inominal rating: 20 kA.

2.3 SWITCHBOARD AND PANELBOARD SUPPRESSOR

A. Manufacturer: Subject to compliance with requirements, provide product by one of the following:

1. Current Technology TG3 Series (Basis of Design).
2. Engineer Approved Equal.

   a. Other manufacturers wishing to have specific products evaluated for equivalence shall provide ATTACHMENT 2 – SWITCHBOARD AND PANELBOARD SPD SPECIFIED PERFORMANCE COMPLIANCE FORM, fully executed with the required documentation, and signed, to demonstrate compliance with the performance requirements of this specification, no less than 10 days prior to the bid date.
   b. Failure to provide the required documentation, for each model to be supplied, no less than 10 days prior to the bid date will disqualify products from consideration for this project.

B. SPDs: Comply with UL 1449 3rd Edition, Type 1.

1. SPDs with the following features and accessories.

   a. Mounted external to electrical equipment.
   b. Integral disconnect switch, where indicated on the drawings.
   c. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
   d. SPD monitoring shall include:

      1.) Indicator lights which display protection status.
      2.) Audible alarm with silence switch.
      3.) Form C contacts rated at 5 A and 250 V, one normally open and one normally closed for remote monitoring of protection status.
      4.) Component tracking and visual indication of percent protection remaining.
      5.) Surge counter which measures, discriminates between and indicates the level of surges.

         a.) Low level surge: 100 A to 500 A
         b.) Medium level surge: 500 A to 3000A.

c.) High level surge: > 3000 A.

6.) Time/date stamp, duration and magnitude of the following events:

a.) Sag
b.) Swell
c.) Voltage drop-outs
d.) Power outages
e.) THD
f.) Frequency excursions
g.) Volts (RMS, per phase)

e. Information from monitoring shall be available through the facility network.

1.) Via ModBus.
2.) Via Ethernet.

f. Integral Test Point with test data from factory provided for comparison. Information is provided in the form of suppressed voltage rating given by portable test set and written on a Diagnostic Signature Card which will be provided with the device. See section 3.2.

C. Comply with UL 1283.

D. Performance Ratings

1. Peak Surge Current Rating
   a. The peak surge current withstand rating per mode shall be as indicated in the table below, for the respective Service Entrance current rating.
   b. The peak surge current rating shall the surge current at which the SPD was tested and which the SPD survived—with less than a 10% degradation in VPR. Testing documentation shall be provided. (Due to present industry testing limitations, surge currents ratings greater than 200 kA will be tested at 200 kA.)
   c. Peak surge current ratings which are the arithmetic sum of the ratings of individual MOVs in a given mode are not acceptable.

2. Repetitive Impulse Rating
   a. The minimum repetitive impulse capacity (10 kA and 20 kV) of the SPD per mode shall not be less than as indicated in the table below, for the respective Service Entrance current rating.
   b. The minimum repetitive impulse capacity shall be the number of impulses at which the SPD was tested and which the SPD survived—with less than a 10% degradation in VPR. Testing documentation shall be provided.
   c. Minimum repetitive ratings which are derived by calculations are not acceptable.

Product Application and Performance Rating Chart						
Service Entrance Current Rating	Surge Current Rating per Mode		Surge Current Rating per Phase		Repetitive Impulse Rating per Mode	
	With No Upstream SPD	With Upstream SPD	With No Upstream SPD	With Upstream SPD	With No Upstream SPD	With Upstream SPD
3000 A (and above)	300 kA	150 kA	600 kA	300 kA	11,000	8,000
2500 A	250 kA	125 kA	500 kA	250 kA	10,000	7,500
2000 A	200 kA	100 kA	400 kA	200 kA	9,000	7,000
1600 A	150 kA	80 kA	300 kA	160 kA	8,000	6,000
1000 A - 1200 A	125 kA	80 kA	250 kA	160 kA	7,500	6,000
800 A	100 kA	50 kA	200 kA	100 kA	7,000	5,000
400 A - 600 A	80 kA	50 kA	160 kA	100 kA	6,000	5,000
200 A	50 kA	50 kA	100 kA	100 kA	5,000	5,000

E. Protection modes and UL 1449 VPR for the applicable modes of grounded WYE/delta and high leg delta circuits shall not exceed the following.

1. For 480Y/277 V and 480 V delta systems:
   a. Line to Neutral: 1200 V
   b. Line to Ground: 1200 V
   c. Neutral to Ground: 1000 V
   d. Line to Line: 2000 V
2. For 208Y/120 V and 208 V delta systems:
   a. Line to Neutral: 700 V
   b. Line to Ground: 700 V
   c. Neutral to Ground: 700 V
   d. Line-to-Line 1200 V

F. SCCR: Equal to or exceed 200 kA.

G. Inominal rating: 20 kA.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Install SPD external to electrical equipment.

C. Install an OCPD or disconnect if required to comply with the UL listing of the SPD.

D. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible, and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

E. Use crimped connectors and splices only. Wire nuts are not acceptable.

F. Utilize the following conductors for connection of the device to the source, for all phase conductors, neutral (if applicable) and ground conductors.

1. Service Entrance Suppressor
   a. For Service Entrances 1200 A and above, utilize #1/0 conductors.
   b. For Service Entrances 200 A - 1000 A utilize Current Technology HPI-6Y low impedance cable assembly.

2. Switchboard and Panelboard Suppressor
   a. For Switchboards, 1200 A and above, utilize #2 AWG conductors.
   b. For Switchboards and Panelboards, 200 A - 1000 A utilize Current Technology HPI-6Y low impedance cable assembly.

3.2 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative.

1. Compare equipment nameplate data for compliance with Drawings and Specifications.

2. Inspect anchorage, alignment, grounding and clearances.

3. Verify that electrical wiring installation complies with manufacturer’s written installation requirements.

4. Testing: Perform the following field tests and inspections and prepare test reports:
   a. After installation of surge protection devices, but before electrical circuitry has been energized, test for compliance with requirements.
   b. Utilize a portable test set and test devices to confirm:
      1.) The suppressed voltage rating of the installed unit is within 10% of the suppressed voltage rating of the device when tested prior to shipment from the factory.
      2.) The SPD is properly installed.
      3.) The presence of an X_0 bond at the most proximal upstream separately derived source.

B. An SPD will be considered defective if it does not pass tests and inspections.

C. Repeat tests and inspection after replacement or repair of defective units.

D. Prepare test-result and inspection reports and submit them to the project engineer.

3.3 STARTUP SERVICE

A. Complete startup checks according to manufacturer's written instructions.

B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests, and reconnect them immediately after the testing is completed.

C. Energize SPDs after power system has been energized, stabilized, and tested.

3.4 DEMONSTRATION

A. Engage a factory authorized service representative to train Owner's maintenance personnel to operate and maintain SPDs.

END OF SECTION 264313

ATTACHMENT 1 – SERVICE ENTRANCE SPD SPECIFIED PERFORMANCE COMPLIANCE FORM

Required for all requests for approval for each model to be supplied.

PERFORMANCE SPECIFICATION	SPEC. SECTION REFERENCE	SPECIFICATION REQUIREMENT	PROPOSED	CONFIRMING DOCUMENTATION REQUIRED	COMPLANCE VERIFIED? YES / NO
Warranty	1.7 A. 1.	20 Years		Published Warranty Certificate	
Tested Surge Current Capacity	2.2 D. 1.	As Per Drawings & Chart in Specification		Independent Test Report	
Repetitive Impulse Capacity	2.2 D. 2.	As Per Drawings & Chart in Specification		Repetitive Test Report Summary	
Overvoltage Protection	2.2 D. 3.	As Per Specification		Test Documentation Confirming Compliance	
Voltage Protection Rating(s)	2.2 E. 2.	120 V Systems: L-N: 700 V, L-G: 700 V, N-G: 700 V, L-L: 1200 V	L-N: _____ L-G: _____ N-G: _____ L-L: _____	Page(s) from UL File Showing Voltage Protection Ratings	
	2.2 E. 1.	277 V Systems: L-N: 1200 V, L-G: 1200 V, N-G: 1000 V, L-L: 2000 V	L-N: _____ L-G: _____ N-G: _____ L-L: _____		
Integrated Monitoring System	2.2 B. 1. d. 4)	Indication of % Protection		Product Data Sheet for Monitoring System	
	2.2 B. 1. d. 5)	Count & Time & Date of: Surges -Low (100-500A) -Med. (500-3000A) -High (Over 3000A)			
	2.2 B. 1. d. 6)	Count of, and			

		Time and Data Stamp and Magnitude and Duration Recording for: Sags Swells Voltage drop-out Power outages THD excursions Frequency excursions Voltage excursions (RMS & per phase)			
Facility Network Based Monitoring System	2.2 B. 1. e.	Information available through the facility network		Print Screen Copy of System Home Page	
Integral Test Port	2.2 B. 1. f.	Integral Interface with Portable Test Set/Surge Generator		Product Data Sheet Showing Test Port Option	
Installed/Field Test Service after Installation	3.2 A. 4.	Confirm Proper Installation and Wiring to SPD and Provide Benchmark of Initial Performance		Provide Data Sheet(s) for Equipment Used to Perform Installed Testing	

Signature confirming the validity of the information given above: _____

ATTACHMENT 2 – SWITCHBOARD & PANELBOARD SPD SPECIFIED PERFORMANCE COMPLIANCE FORM

Required for all requests for approval for each model to be supplied.

PERFORMANCE SPECIFICATION	SPEC. SECTION REFERENCE	SPECIFICATION REQUIREMENT	PROPOSED	CONFIRMING DOCUMENTATION REQUIRED	COMPLIANCE VERIFIED? YES / NO
Warranty	1.7 A. 1.	15 Years (20 Years with Upstream SL3)		Published Warranty Certificate	
Tested Surge Current Capacity	2.3 D. 1.	As Per Drawings & Chart in Specification		Independent Test Report	
Repetitive Impulse Capacity	2.3 D. 2.	As Per Drawings & Chart in Specification		Repetitive Test Report Summary	
Voltage Protection Rating(s)	2.3 E. 2.	120 V Systems: L-N: 700 V, L-G: 700 V, N-G: 700 V, L-L: 1200 V	L-N: _____ L-G: _____ N-G: _____ L-L: _____	Page(s) from UL File Showing Voltage Protection Ratings	
	2.3 E. 1.	277 V Systems: L-N: 1200 V, L-G: 1200 V, N-G: 1000 V, L-L: 2000 V	L-N: _____ L-G: _____ N-G: _____ L-L: _____		
Integrated Monitoring System	2.3 B. 1. d. 4)	Indication of % Protection		Product Data Sheet for Monitoring System	
	2.3 B. 1. d. 5)	Count & Time & Date of: Surges -Low (100-500A) -Med. (500-3000A) -High (Over 3000A)			
	2.3 B. 1. d. 6)	Count of, and Time and Data Stamp and Magnitude and Duration Recording for:			

		Sags Swells Voltage drop-out Power outages THD excursions Frequency excursions Voltage excursions (RMS & per phase)			
Facility Network Based Monitoring System	2.3 B. 1. e.	Information available through the facility network		Print Screen Copy of System Home Page	
Integral Test Port	2.3 B. 1. f.	Integral Interface with Portable Test Set/Surge Generator		Product Data Sheet Showing Test Port Option	
Installed/Field Test Service after Installation	3.2 A. 4.	Confirm Proper Installation and Wiring to SPD and Provide Benchmark of Initial Performance		Provide Data Sheet(s) for Equipment Used to Perform Installed Testing	

Signature confirming the validity of the information given above: _____

SECTION 265100 - INTERIOR LIGHTING

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. Interior solid-state luminaires that use LED technology.
   2. Lighting fixture supports.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. LED: Light-emitting diode.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

   1. Arrange in order of luminaire designation.
   2. Include data on features, accessories, and finishes.
   3. Include physical description and dimensions of luminaires.
   4. Include emergency lighting units, including batteries and chargers.
   5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.

B. Shop Drawings: For nonstandard or custom luminaires.

   1. Include plans, elevations, sections, and mounting and attachment details.
   2. Include details of luminaire 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.

C. LEED Submittals:

1. Comply with Section 01 3515 LEED Certification Procedures. Provide all information required on the LEED Submittal Cover Sheet included at the end of this Section

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) 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. Lighting luminaires.
2. Suspended ceiling components.
3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches (300 mm) of the plane of the luminaires.
4. Structural members to which equipment luminaires will be attached.
5. Initial access modules for acoustical tile, including size and locations.
6. Items penetrating finished ceiling, including the following:

a. Other luminaires.
b. Air outlets and inlets.
c. Speakers.
d. Sprinklers.
e. Access panels.
f. Ceiling-mounted projectors.

7. Moldings.

B. Qualification Data: For testing laboratory providing photometric data for luminaires.

C. Seismic Qualification Certificates: For luminaires, 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.

D. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Product Certificates: For each type of luminaire.

F. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.7 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

C. Provide luminaires from a single manufacturer for each luminaire type.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.9 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

B. Warranty Period: 5 year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7

B. Seismic Performance: Luminaires and lamps shall be labeled vibration and shock resistant.

1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified."

2.2 LUMINAIRE REQUIREMENTS

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. Recessed Fixtures: Comply with NEMA LE 4.

C. CRI of minimum 80. CCT as indicated on lighting schedule.

D. Rated lamp life of 50,000hours.

E. Dimming as indicated on lighting schedule.

F. Integral driver.

G. Nominal Operating Voltage: As indicated on lighting schedule.

2.3 PRODUCTS.

A. Fixture basis of design is determined by lighting schedule on construction documents.

1. Equivalency of substitutions to products on lighting schedule shall be at the sole discretion of the Engineer.

2.4 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions.

1. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
2. Glass: Annealed crystal glass unless otherwise indicated.
3. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.

C. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:

a. "USE ONLY" and include specific lamp type.
b. Lamp diameter, shape, size, wattage, and coating.
c. CCT and CRI for all luminaires.

2.5 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.6 LUMINAIRE FIXTURE SUPPORT COMPONENTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.

C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).

D. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.

E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before fixture installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.3 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Provide support for luminaire without causing deflection of ceiling or wall.
4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.

D. Flush-Mounted Luminaire Support:

1. Secured to outlet box.

2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
3. Trim ring flush with finished surface.

E. Wall-Mounted Luminaire Support:

1. Attached to structural members in walls.
2. Do not attach luminaires directly to gypsum board.

F. Ceiling-Mounted Luminaire Support:

1. Ceiling mount per manufacturer instructions.

G. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
3. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

H. Ceiling-Grid-Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

I. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. Comply with requirements for startup specified in Section 260943.16 "Addressable-Fixture Lighting Controls."

B. Comply with requirements for startup specified in Section 260943.23 "Relay-Based Lighting Controls."

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION 265100

SECTION 270526 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1- GENERAL

1.1 SUMMARY

A. Section Includes:

1. Grounding conductors.
2. Grounding connectors.
3. Grounding busbar.
4. Grounding rods.
5. Grounding labeling.

1.2 DEFINITIONS

A. BCT: Bonding conductor for telecommunications.

B. EMT: Electrical metallic tubing.

C. TGB: Telecommunications grounding busbar.

D. TMGB: Telecommunications main grounding busbar.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, or Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.6 QUALIFICATIONS

A. Communications Cabling: The Contractor shall have (5) five years of documented experience performing cable placement, splicing, termination, connecting, and testing for each of the media types and (3) three years of applicable experience with the proposed system manufacturer. In the case of newer technologies that do not have a (3) three year history, the Contractor shall have documented experience for at least half of the lifetime of the new technology. The approved contractor shall, at a minimum, maintain a ratio of one manufacturer or BICSI certified installer for every two non-certified installers assigned to the project.

B. The contractor shall have on staff a BICSI Certified RCDD as a permanent employee. This staff member shall have been on staff for a minimum of (1) one year prior to the date of this projects release for bid.

C. The contractor shall have on staff at least (1) one BICSI Certified Technician and this staff member shall have been a full time employee for no less than (1) one year prior to the date of this projects release for bid. A BICSI Certified Technician shall be employed as the on-site Field Supervisor for this project.

D. The contractor shall provide resumes for the Project Manager, Supervisors and any skilled technicians or installers. Each resume shall include applicable certification documents provided by the manufacturer or BICSI.

1. Project Manager, Supervisors, and Principal Skilled Technicians: minimum of (5) five years' experience in like work.
2. Category 6 Unshielded Twisted Pair and Fiber Optic Cable Technicians: documented training, licensing, and/or certification for the types of media specified, as applicable as well as certification from the manufacturer of the solution chosen by the owner.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, field inspector and company. The contractor shall provide resumes for the Project Manager, Supervisors and any skilled technicians or installers. Each resume shall include applicable certification documents provided by the manufacturer or BICSI.

1. Project Manager, installation supervisor, and Principal Skilled Technicians: As a minimum be required to have no less than (5) five years' experience in like work.
2. The Company/Contractor proposing shall provide historical data confirming the company has a minimum of (5) five years applicable experience.
3. The Company/Contractor shall have a minimum of (3) three projects of similar size and type within the last (2) years. References for all submitted projects are required to assist with the evaluation.

B. Category 6 Unshielded Twisted Pair and Fiber Optic Cable Technicians: Documented training, licensing, and/or certification for the types of media specified, as applicable as well as certification from the manufacturer of the solution chosen by the owner.

C. Source quality-control reports.

D. Field quality-control reports.

E. As-Built Data: Plans showing as-built locations of grounding and bonding infrastructure, including the following:

1. Ground rods.
2. Ground and roof rings.
3. BCT, TMGB, TGBs, and routing of their bonding conductors.

PART 2- PRODUCTS

2.1 SYSTEM COMPONENTS

A. Comply with J-STD-607-A.

2.2 CONDUCTORS

A. Manufacturers: Subject to compliance with requirements. Provide products by one of the following available manufacturers that may be incorporated into the Work include, but are not limited to, the following:

1. Harger Lightning and Grounding.
2. Panduit Corp.
3. Tyco Electronics Corp.

B. Comply with UL 486A-486B.

C. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.

1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.
2. Cable Tray Equipment Grounding Wire: No. 6 AWG.

D. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmils (14.2 sq. mm), 14 strands of No. 17 AWG conductor and 1/4 inch, (6.3 mm), in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Tinned-copper tape, braided conductors terminated with two-hole copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

2.3 CONNECTORS

A. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.

B. Manufacturers: Subject to compliance with requirements, provide products by the following available manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:

1. Burndy; Part of Hubbell Electrical Systems.
2. Chatsworth Products, Inc.
3. Harger Lightning and Grounding.
4. Panduit Corp.
5. Tyco Electronics Corp.

C. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.

1. Electroplated tinned copper, C and H shaped.

D. Busbar Connectors: Cast silicon bronze, solder-less compression or exothermic-type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch, (15.8- or 25.4-mm), centers for a two-bolt connection to the busbar.

E. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.4 GROUNDING BUSBARS

A. Manufacturers: Subject to compliance with requirements, provide products by the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Chatsworth Products, Inc.
2. Harger Lightning and Grounding.
3. Panduit Corp.

B. TMGB: Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, 1/4 by 4 inches, (6.3 by 100 mm), in cross section, length as indicated on Drawings. The busbar shall be NRTL listed for use as TMGB and shall comply with J-STD-607-A.

1. Predrilling shall be for use with lugs specified in this Section.
2. Mounting Hardware: Stand-off brackets that provide a 4-inch (100-mm) clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

C. TGB: Predrilled rectangular bars of hard-drawn solid copper, 1/4 by 2 inches (6.3 by 50mm), in cross section, length as indicated on Drawings. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467 and shall comply with J-STD-607-A.

1. Predrilling shall be with holes for use with lugs specified in this Section.
2. Mounting Hardware: Stand-off brackets that provide at least a 2-inch, (50-mm), clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards and impulse tested at 5000 V.

D. Rack and Cabinet Grounding Busbar: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467 and complying with J-STD-607-A. Predrilling shall be with holes for use with lugs specified in this Section.

1. Cabinet-Mounted Busbar: Terminal block, with stainless-steel or copper-plated hardware for attachment to the cabinet.
2. Rack-Mounted Horizontal Busbar: Designed for mounting in 19- or 23-inch (483- or 584-mm) equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.
3. Rack-Mounted Vertical Busbar: 72 or 36 inches, (1827 or 914 mm long, with), stainless-steel or copper-plated hardware for attachment to the rack.

2.5 GROUND RODS

A. Manufacturers: Subject to compliance with requirements, 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:

1. Harger Lightning and Grounding.
2. Tyco Electronics Corp.

B. Ground Rods: Copper-clad, Zinc-coated, Stainless steel, sectional type, 3/4 inch by 10 feet, (19 mm by 3 m), 5/8 by 96 inches, (16 by 2400 mm), in diameter.

2.6 LABELING

A. Manufacturers: Subject to compliance with requirements, 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:

1. Brother International Corporation.
2. HellermannTyton.
3. Panduit Corp.

B. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives and inks used by label printers.

C. Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.

PART 3- EXECUTION

3.1 EXAMINATION

A. Examine the ac grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of the electrical system.

B. Inspect the test results of the ac grounding system measured at the point of BCT connection.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with connection of the BCT only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Bonding shall include the ac utility power service entrance, the communications cable entrance, and the grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others.

B. Comply with NECA 1.

C. Comply with J-STD-607-A.

3.3 APPLICATION

A. Conductors: Install solid conductor for No. 8AWG and smaller and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

1. The bonding conductors between the TGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
2. The bonding conductors between the TMGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.

B. Underground Grounding Conductors: Install bare tinned- copper conductor, No. 2 AWG minimum.

C. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

D. Conductor Support:

1. Secure grounding and bonding conductors at intervals of not less than 36 inches (900 mm.)

E. Grounding and Bonding Conductors:

1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
2. Install without splices.
3. Support at not more than 36-inch (900-mm) intervals.
4. Install grounding and bonding conductors in 3/4-inch (21-mm) PVC conduit until conduit enters a telecommunications room. The grounding and bonding conductor pathway

through a plenum shall be in EMT. Conductors shall not be installed in EMT unless otherwise indicated.

a. If grounding and bonding conductor is installed in ferrous metallic conduit, bond the conductor to the conduit using a grounding bushing that complies with requirements in Section 270528 "Pathways for Communications Systems," and bond both ends of the conduit to a TGB.

3.4 GROUNDING ELECTRODE SYSTEM

A. The BCT between the TMBG and the ac service equipment ground shall not be smaller than No. 3/0AWG.

3.5 GROUNDING BUSBARS

A. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers 2 inches, (50 mm), minimum from wall and 12 inches, (300 mm), above finished floor unless otherwise indicated.

B. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

3.6 CONNECTIONS

A. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6 AWG.

B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.

C. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:

1. Use crimping tool and the die specific to the connector.
2. Pre-twist the conductor.
3. Apply an antioxidant compound to all bolted and compression connections.

D. Primary Protector: Bond to the TMGB with insulated bonding conductor.

E. Interconnections: Interconnect all TGBs and the TMGB with the telecommunications backbone conductor. If more than one TMGB is installed, interconnect TMGBs using the grounding equalizer conductor. The telecommunications backbone conductor and grounding equalizer conductor size shall not be less than 2 kcmils/linear foot, (1 sq. mm/linear meter), of conductor length and up to a maximum size of No. 3/0 AWG 168 kcmils, (85 sq. mm), unless otherwise indicated.

F. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install top-mounted or vertically mounted rack grounding busbar unless the enclosure and rack are manufactured with the busbar. Bond the equipment grounding busbar to the TGB utilizing No. 6 AWG bonding conductors.

G. Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space, bond each TGB and TMGB to the vertical steel of the building frame.

H. Electrical Power Panelboards: Where an electrical panelboard for telecommunications equipment is located in the same room or space, bond each TGB to the ground bar of the panelboard.

I. Shielded Cable: Bond the shield of shielded cable to the TGB in communications rooms and spaces. Comply with TIA/EIA-568-B.1 and TIA/EIA-568-B.2 when grounding screened, balanced, twisted-pair cables.

J. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.

K. Access Floors: Bond all metal parts of access floors to the TGB.

3.7 IDENTIFICATION

A. Labels shall be preprinted or computer-printed type.

1. Label TMGB(s) with "ts-TMGB," where "ts" is the telecommunications space identifier for the space containing the TMGB.
2. Label TGB(s) with "ts-TGB," where "ts" is the telecommunications space identifier for the space containing the TGB.
3. Label the BCT and each telecommunications backbone conductor at its attachment point: "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
2. Test the bonding connections of the system using an ac earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing a TMGB and a TGB and using the process recommended in the BICSI TDMM. Conduct tests with the facility in operation.

    a. Measure the resistance between the busbar and the nearest available grounding electrode. The maximum acceptable value of this bonding resistance is 100 milliohms.

3. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent.

a. With the grounding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the TMGB and each TGB. Maximum acceptable ac current level is 1 A.

C. Excessive Ground Resistance: If resistance to ground at the BCT exceeds 5ohms, notify Architect promptly and include recommendations to reduce ground resistance.

D. Grounding system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION 270526

SECTION 270528 - PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 -GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Optical-fiber-cable pathways and fittings.
4. Boxes, enclosures, and cabinets.
5. Handholes and boxes for exterior underground cabling.

B. Related Requirements:

1. Section 26 0533 "Raceways and Boxes for Electrical Systems" for conduits, wireways, surface raceways, boxes, enclosures, cabinets, handholes, and faceplate adapters serving electrical systems.
2. Section 27 0536 “Cable Trays for Communication Systems”

1.2 ACTION SUBMITTALS

A. Product Data: For surface pathways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.
2. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings: For custom enclosures and cabinets.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.

2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, or Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.4 QUALIFICATIONS

A. Communications Cabling: The Contractor shall have (5) five years of documented experience performing cable placement, splicing, termination, connecting, and testing for each of the media types and (3) three years of applicable experience with the proposed system manufacturer. In the case of newer technologies that do not have a (3) three year history, the Contractor shall have documented experience for at least half of the lifetime of the new technology. The approved contractor shall, at a minimum, maintain a ratio of one manufacturer or BICSI certified installer for every two non-certified installers assigned to the project.

B. The contractor shall have on staff a BICSI Certified RCDD as a permanent employee. This staff member shall have been on staff for a minimum of (1) one year prior to the date of this projects release for bid.

C. The contractor shall have on staff at least (1) one BICSI Certified Technician and this staff member shall have been a full time employee for no less than (1) one year prior to the date of this projects release for bid. A BICSI Certified Technician shall be employed as the on-site Field Supervisor for this project.

D. The contractor shall provide resumes for the Project Manager, Supervisors and any skilled technicians or installers. Each resume shall include applicable certification documents provided by the manufacturer or BICSI.

1. Project Manager, Supervisors, and Principal Skilled Technicians: minimum of (5) five years' experience in like work.
2. Category 6 Unshielded Twisted Pair and Fiber Optic Cable Technicians: documented training, licensing, and/or certification for the types of media specified, as applicable as well as certification from the manufacturer of the solution chosen by the owner.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, field inspector and company. The contractor shall provide resumes for the Project Manager, Supervisors and any skilled technicians or installers. Each resume shall include applicable certification documents provided by the manufacturer or BICSI.

1. Project Manager, installation supervisor, and Principal Skilled Technicians: As a minimum be required to have no less than (5) five years' experience in like work.
2. The Company/Contractor proposing shall provide historical data confirming the company has a minimum of (5) five years applicable experience.
3. The Company/Contractor shall have a minimum of (3) three projects of similar size and type within the last (2) years. References for all submitted projects are required to assist with the evaluation.

B. Category 6 Unshielded Twisted Pair and Fiber Optic Cable Technicians: Documented training, licensing, and/or certification for the types of media specified, as applicable as well as certification from the manufacturer of the solution chosen by the owner.

C. Source quality-control reports.

D. Field quality-control reports.

E. Seismic Qualification Certificates: For pathway racks, enclosures, cabinets, equipment racks and their mounting provisions, include those for internal components, from manufacturer.

PART 2 -PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. General Requirements for Metal Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-B.

B. EMT: Comply with ANSI C80.3 and UL 797.

C. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
2. Fittings for EMT:

   a. Material: Steel or die cast.
   b. Type: Setscrew or compression.

3. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions, where installed and including flexible external bonding jumper.

D. Joint Compound for GRC or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies and compounded for use to lubricate and protect threaded conduit joints from corrosion, to enhance their conductivity.

E. FLEXABLE METAL CONDUIT SHALL NOT BE USED FOR COMMUNICATIONS PATHWAYS.

2.2 NONMETALLIC CONDUITS AND FITTINGS

A. General Requirements for Nonmetallic Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency and marked for intended location and application.
2. Comply with TIA-569-B.

B. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

C. Continuous HDPE: Comply with UL 651B.

D. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

E. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

F. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.3 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

A. Description: Comply with UL 2024; flexible-type pathway, approved for plenum riser or

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-B.

2.4 BOXES, ENCLOSURES, AND CABINETS

A. General Requirements for Boxes, Enclosures, and Cabinets:

1. Comply with TIA-569-B.
2. Boxes, enclosures and cabinets installed in wet locations shall be listed for use in wet locations.

B. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy aluminum, Type FD, with a gasketed cover.

C. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

D. Metal Floor Boxes:

1. Material: Cast metal or sheet metal.
2. Type: Fully adjustable, Semi-adjustable.
3. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Nonmetallic Floor Boxes: Nonadjustable, round or rectangular.

1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum or galvanized, cast iron with gasketed cover.

G. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep) or 4 inches by 2-1/8 inches by 2-1/8 inches deep (100 mm by 60 mm by 60 mm deep).

H. Gangable boxes are prohibited.

I. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

J. Coordinate "Hinged-Cover Enclosures" Paragraph below with Drawings if hinged cover enclosures other than NEMA 250, Type 1 are required, such as for very dusty areas; or if consideration should be given to use of NEMA 250, Type 3R or Type 12 enclosures.

K. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1, Type 3R, Type 4 and Type 12, (dependent on environmental conditions), with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures: Plastic or fiberglass, finished inside with radio-frequency-resistant paint.
3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

L. Cabinets:

1. NEMA 250, Type 1, Type 3R, Type 12, (dependent on environmental conditions), galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency and marked for intended location and application.

2.5 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND CABLING

A. General Requirements for Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency and marked for intended location and application.
3. Comply with TIA-569-B.

4. Handholes/Manholes shall be traffic rated when installed in parking lots, access roads and streets.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin and reinforced with steel, fiberglass, or a combination of the two.

1. Standard: Comply with SCTE 77.
2. Configuration: Designed for flush burial with open, closed, integral closed, bottom unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, "COMMUNICATIONS."

PART 3 - EXECUTION

3.1 PATHWAY APPLICATION

A. Outdoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed Conduit: EMT, RNC, Type EPC-40-PVC, RNC and Type EPC-80-PVC.
2. Concealed Conduit, Aboveground: EMT, RNC, Type EPC-40-PVC.
3. Underground Conduit: RNC, Type EPC-40-PVC Type EPC-80-PVC, direct buried concrete encased.
4. Boxes and Enclosures, above ground: NEMA 250, Type 3R Type 4.

B. Indoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT or RNC.
2. Exposed, Not Subject to Severe Physical Damage: EMT, RNC identified for such use.
3. Concealed in Ceilings and Interior Walls and Partitions: EMT RNC, Type EPC-40-PVC or inner duct.
4. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical-fiber-cable pathway, Plenum-type, communications-cable pathway, EMT.
5. Pathways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: Riser-type, optical-fiber-cable pathway. Riser-type, communications-cable pathway EMT.
6. Pathways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: General-use, optical-fiber-cable pathway Riser-type, optical-fiber-cable pathway. Plenum-type, optical-fiber-cable pathway. General-use, communications-cable pathway. Riser-type, communications-cable pathway. Plenum-type, communications-cable pathway. EMT.
7. Boxes and Enclosures: NEMA 250 Type 1, except use NEMA 250 Type 4 stainless steel nonmetallic in institutional and commercial kitchens and damp or wet locations.

C. Minimum Pathway Size: 1 inch (27mm) trade size. Minimum size for optical-fiber cables is 1 inch (27 mm).

D. Pathway Fittings: Compatible with pathways and suitable for use and location.

1. Rigid Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. EMT: Use setscrew or compression, steel and cast-metal fittings. Comply with NEMA FB 2.10.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Install surface pathways only where indicated on Drawings.

G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg. F, (49 deg. C).

3.2 INSTALLATION

A. Comply with NECA 1, NECA 101, and TIA-569-B for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum pathways. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.

B. Keep pathways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.

C. Comply with requirements in Section 26 0529 "Hangers and Supports for Electrical Systems" for hangers and supports.

D. Arrange stub-ups so curved portions of bends are not visible above finished slab.

E. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches (300 mm) of changes in direction. Utilize long radius ells for all optical-fiber cables.

F. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

G. Pathways Embedded in Slabs:

1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot (3-m) intervals.
2. Arrange pathways to cross building expansion joints at right angles with expansion fittings.
3. Arrange pathways to keep a minimum of 1 inch, (25 mm), of concrete cover in all directions.
4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.

H. Stub-ups to Above Recessed Ceilings:

1. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

I. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.

J. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.

K. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

L. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

M. Spare Pathways: Install pull wires in empty pathways. Cap underground pathways designated as spare above grade alongside pathways in use.

N. "Pathways for Optical-Fiber and Communications Cable" Paragraph below is applicable for EMT, RMC, RNC, and optical-fiber and communications-cable pathways.

O. Pathways for Optical-Fiber and Communications Cable: Install pathways as follows:

1. 1-Inch (27-mm) Trade Size and Larger: Install pathways in maximum lengths of 75 feet (23 m).
2. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements.

P. Install pathway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound.

Q. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service pathway enters a building or structure.
3. Where otherwise required by NFPA 70.

R. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg. F, (17 deg. C) and that has straight-run length that exceeds 25 feet, (7.6 m). Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg. F, (55 deg. C) and that has straight-run length that exceeds 100 feet, (30 m).
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:

    a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg. F, (70 deg. C), temperature change.
    b. Outdoor Locations Exposed to Direct Sunlight: 155 deg. F, (86 deg. C), temperature change.
    c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg. F, (70 deg. C), temperature change.
    d. Ceilings and Attics: 135 deg. F, (75 deg. C), temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg. F, (0.06 mm per meter of length of straight run per deg. (C), of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg., F, (0.0115), mm per meter of length of straight run per deg., (C), of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

S. Mount boxes at heights indicated on Drawings in accordance with ADA requirements. Install boxes with height measured to bottom of box unless otherwise indicated.

T. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 31 2000 "Earth Moving" for pipe less than 6 inches, (150 mm), in nominal diameter.
2. Install backfill as specified in Section 31 2000 "Earth Moving."
3. After installing conduit, backfill and compact. After placing controlled backfill to within 12 inches, (300 mm), of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 31 2000, "Earth Moving."
4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.

    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches, (75 mm), of concrete for a minimum of 12 inches, (300 mm), on each side of the coupling.
    b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches, (1500 mm), from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

5. Underground Warning Tape: Comply with requirements in Section 26 0553 "Identification for Electrical Systems."

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch, (25 mm), above finished grade.

C. Install handholes with bottom below frost line, in accordance with manufacturer’s specifications.

D. Field cut openings for conduits according to enclosure manufacturer's written instructions.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 27 0544, "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.6 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 07 8413, "Penetration Firestopping."

3.7 PROTECTION

A. Protect coatings, finishes, and cabinets from damage or deterioration.

END OF SECTION 270528

SECTION 270536 - CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Contractor is responsible for providing and installing a complete Cable tray system that meets or exceeds the specifications listed below.

1. Ladder cable trays. (Inside the ER and TR's)

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For each type of cable tray.

C. Delegated-Design Submittal: For seismic restraints.

1. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer, licensed in the state where project is located and who is responsible for their preparation.
2. Design Calculations: Calculate requirements for selecting seismic restraints.
3. Detail fabrication, including anchorages and attachments to structure and to supported cable trays.

1.3 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For cable trays, accessories, and components, from manufacturer.

B. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, or Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.5 QUALIFICATIONS

A. Communications Cabling: The Contractor shall have (5) five years of documented experience performing cable placement, splicing, termination, connecting, and testing for each of the media types and (3) three years of applicable experience with the proposed system manufacturer. In the case of newer technologies that do not have a (3) three year history, the Contractor shall have documented experience for at least half of the lifetime of the new technology. The approved contractor shall, at a minimum, maintain a ratio of one manufacturer or BICSI certified installer for every two non-certified installers assigned to the project.

B. The contractor shall have on staff a BICSI Certified RCDD as a permanent employee. This staff member shall have been on staff for a minimum of (1) one year prior to the date of this projects release for bid.

C. The contractor shall have on staff at least (1) one BICSI Certified Technician and this staff member shall have been a full time employee for no less than (1) one year prior to the date of this projects release for bid. A BICSI Certified Technician shall be employed as the on-site Field Supervisor for this project.

D. The contractor shall provide resumes for the Project Manager, Supervisors and any skilled technicians or installers. Each resume shall include applicable certification documents provided by the manufacturer or BICSI.

1. Project Manager, Supervisors, and Principal Skilled Technicians: minimum of (5) five years' experience in like work.
2. Category 6 Unshielded Twisted Pair and Fiber Optic Cable Technicians: documented training, licensing, and/or certification for the types of media specified, as applicable as well as certification from the manufacturer of the solution chosen by the owner.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, field inspector and company. The contractor shall provide resumes for the Project Manager, Supervisors and any skilled technicians or installers. Each resume shall include applicable certification documents provided by the manufacturer or BICSI.

1. Project Manager, installation supervisor, and Principal Skilled Technicians: As a minimum be required to have no less than (5) five years' experience in like work.
2. The Company/Contractor proposing shall provide historical data confirming the company has a minimum of (5) five years applicable experience.
3. The Company/Contractor shall have a minimum of (3) three projects of similar size and type within the last (2) years. References for all submitted projects are required to assist with the evaluation.

B. Category 6 Unshielded Twisted Pair and Fiber Optic Cable Technicians: Documented training, licensing, and/or certification for the types of media specified, as applicable as well as certification from the manufacturer of the solution chosen by the owner.

C. Source quality-control reports.

D. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cable tray supports and seismic bracing.

B. Seismic Performance: Cable trays and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. Component Importance Factor: 1.5, 1.0.

2.2 GENERAL REQUIREMENTS FOR CABLE TRAYS

A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.

B. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations. Cable tray shall be installed with a 40% fill capacity after installation is complete.

C. Structural Performance: See articles on individual cable tray types for specific values for uniform load distribution, concentrated load, and load and safety factor parameters.

2.3 LADDER CABLE TRAYS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. CPI or owner and consultant approved equal

B. Description:

1. Configuration: Two I-beam side rails with transverse rungs welded to side rails.
2. Rung Spacing: 12 inches, (300 mm), no greater than 12”, o.c.
3. Radius-Fitting Rung Spacing: 9 inches, (225 mm), at center of tray's width.
4. Minimum Cable-Bearing Surface for Rungs: 7/8-inch, (22-mm), width with radius edges.
5. No portion of the rungs shall protrude below the bottom plane of side rails.
6. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb, (90-kg), concentrated load, when tested according to NEMA VE 1.
7. Load capacity: 132 lb/ft with support every 5', (200 kg/m with support every 1.5 m). Straight Section Lengths: 10 feet, (3 m), 12 feet, (3.6 m), except where shorter lengths are required to facilitate tray assembly.
8. Width: 12 inches, (300 mm), 18 inches, (457.2mm), unless otherwise indicated on Drawings.
9. Fitting Minimum Radius: 24 inches, (600 mm), 36 inches (900 mm), 48 inches, (1200 mm), dependent on cable tray sized used
10. Class Designation: Comply with NEMA VE 1, Class 12B, Class 12C, Class 20B, and Class 20C.
11. Splicing Assemblies: Bolted type using serrated flange locknuts.

12. Hardware and Fasteners: ASTM F 593 and ASTM F 594 stainless steel, Type 316 Steel, zinc plated according to ASTM B 633.
13. Splice Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

2.4 MATERIALS AND FINISHES

A. Steel:

1. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of ASTM A 1011/A 1011M, SS, Grade 33, ASTM A 1008/A 1008M, Grade 33, Type 2.
2. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
3. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
4. Finish: Mill galvanized before fabrication.

    a. Hardware: Galvanized, ASTM B 633, Chromium-zinc plated, ASTM F 1136.

5. Finish: Electro galvanized before fabrication.
6. Finish: Hot-dip galvanized after fabrication.

    a. Hardware: Chromium-zinc plated ASTM F 1136, Stainless steel, Type 316, ASTM F 593 and ASTM F 594.

7. Finish: Epoxy-resin, Powder-coat enamel paint.

    a. Hardware: Chromium-zinc plated ASTM F 1136, Stainless steel, Type 316, ASTM F 593 and ASTM F 594.

8. Finish: Factory-standard primer, ready for field painting, with chromium-zinc-plated hardware according to ASTM F 1136.
9. Finish: Black oxide finish for support accessories and miscellaneous hardware according to ASTM D 769.

B. Aluminum:

1. Materials: Alloy 6063-T6 according to ANSI H35.1/H 35.1M for extruded components, and Alloy 5052-H32 or Alloy 6061-T6 according to ANSI H35.1/H 35.1M for fabricated parts.
2. Hardware: Chromium-zinc-plated steel, ASTM F 1136, Stainless steel, Type 316, ASTM F 593 and ASTM F 594.
3. Hardware for Aluminum Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.

C. Stainless Steel:

1. Materials: Low-carbon, passivated, stainless steel, Type 304L or Type 316L, ASTM F 593 and ASTM F 594.

2.5 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows and other fittings as indicated, of same materials and finishes as cable tray.

B. Barrier Strips: Same materials and finishes as for cable tray.

C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.6 WARNING SIGNS

A. Lettering: 1-1/2-inch, (40-mm-), high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel."

B. Comply with requirements for fasteners in Section 260553 "Identification for Electrical Systems."

2.7 SOURCE QUALITY CONTROL

A. Testing: Test and inspect cable trays according to NEMA VE 1.

PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION

A. Install cable trays according to NEMA VE 2.

B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, and bonding.

C. Fasten cable tray supports to building structure and install seismic restraints.

D. Design fasteners and supports to carry cable tray, the cables and a concentrated load of 200 lb., (90 kg). Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems." Comply with seismic-restraint details according to Section 260548, "Vibration and Seismic Controls for Electrical Systems."

E. Support wire-basket cable trays with, trapeze hangers, and/or wall brackets. Center support only, will not be accepted.

F. Support: trapeze hangers for wire-basket trays with 3/8-inch, (10-mm-), diameter rods.

G. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.

H. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA FG 1, NEMA VE 2. Space connectors and set gaps according to applicable standard.

I. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 "Penetration Firestopping."

J. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

K. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15 000 V.

L. Install permanent covers, if used, after installing cable. Install cover clamps according to NEMA VE 2.

M. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.2 CABLE TRAY GROUNDING

A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Cable trays with communications cable shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

C. Cable trays with control conductors shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

D. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

3.3 CABLE INSTALLATION

A. Install cables only when each cable tray run has been completed and inspected.

B. Fasten cables on horizontal runs with Velcro; tie wraps shall not be used. Fasten cables on vertical runs to cable trays every 18 inches (450 mm).

C. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 60 inches (1524 mm).

D. Tie MI cables down every 36 inches (900 mm) where required to provide a 2-hour fire rating and every 72 inches (1800 mm) elsewhere.

E. In existing construction, remove inactive or dead cables from cable trays.

3.4 CONNECTIONS

A. Connect raceways to cable trays according to requirements in NEMA VE 2.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
3. Verify that the number, size and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and re-torque in suspect areas.
7. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
8. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

B. Prepare test and inspection reports.

3.6 PROTECTION

A. Protect installed cable trays and cables.

END OF SECTION 270536

SECTION 270544 - SLEEVES & SLEEVE SEALS FOR COMMUNICATIONS PATHWAYS & CABLING

PART 1- GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves for pathway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Silicone sealants.

B. Related Requirements:

1. Section 07 8413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:

1. Product Data for Credit EQ 4.1: For sealants, documentation including printed statement of VOC content.
2. Laboratory Test Reports for Credit EQ 4: For sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

1.3 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, or Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.4 QUALIFICATIONS

A. Communications Cabling: The Contractor shall have (5) five years of documented experience performing cable placement, splicing, termination, connecting, and testing for each of the media types and (3) three years of applicable experience with the proposed system manufacturer. In the case of newer technologies that do not have a (3) three year history, the Contractor shall have documented experience for at least half of the lifetime of the new technology. The approved contractor shall, at a minimum, maintain a ratio of one manufacturer or BICSI certified installer for every two non-certified installers assigned to the project.

B. The contractor shall have on staff a BICSI Certified RCDD as a permanent employee. This staff member shall have been on staff for a minimum of (1) one year prior to the date of this projects release for bid.

C. The contractor shall have on staff at least (1) one BICSI Certified Technician and this staff member shall have been a full time employee for no less than (1) one year prior to the date of this projects release for bid. A BICSI Certified Technician shall be employed as the on-site Field Supervisor for this project.

D. The contractor shall provide resumes for the Project Manager, Supervisors and any skilled technicians or installers. Each resume shall include applicable certification documents provided by the manufacturer or BICSI.

1. Project Manager, Supervisors, and Principal Skilled Technicians: minimum of (5) five years' experience in like work.
2. Category 6 Unshielded Twisted Pair and Fiber Optic Cable Technicians: documented training, licensing, and/or certification for the types of media specified, as applicable as well as certification from the manufacturer of the solution chosen by the owner.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, field inspector and company. The contractor shall provide resumes for the Project Manager, Supervisors and any skilled technicians or installers. Each resume shall include applicable certification documents provided by the manufacturer or BICSI.

1. Project Manager, installation supervisor, and Principal Skilled Technicians: As a minimum be required to have no less than (5) five years' experience in like work.
2. The Company/Contractor proposing shall provide historical data confirming the company has a minimum of (5) five years applicable experience.
3. The Company/Contractor shall have a minimum of (3) three projects of similar size and type within the last (2) years. References for all submitted projects are required to assist with the evaluation.

B. Category 6 Unshielded Twisted Pair and Fiber Optic Cable Technicians: Documented training, licensing, and/or certification for the types of media specified, as applicable as well as certification from the manufacturer of the solution chosen by the owner.

C. Source quality-control reports.

D. Field quality-control reports.

PART 2- PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch, (0.6-mm), minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. Sleeves for Rectangular Openings:

1. Material: Galvanized-steel sheet.
2. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches, (1270 mm) and with no side larger than 16 inches, (400 mm), thickness shall be 0.052 inch, (1.3 mm).
b. For sleeve cross-section rectangle perimeter 50 inches, (1270 mm), or more and one or more sides larger than 16 inches, (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.

1. Manufacturers: Subject to compliance with requirements, 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:

a. Advance Products & Systems, Inc.
b. CALPICO, Inc.
c. Metraflex Company (The).
d. Pipeline Seal and Insulator, Inc.
e. Proco Products, Inc.

2. Sealing Elements: EPDM, Nitrile, (Buna N), rubber 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, Plastic, Stainless steel.
4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, Stainless steel with length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

1. Manufacturers: Subject to compliance with requirements, 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:

a. Presealed Systems.

2.4 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
2. Sealant shall be used in accordance with manufacturer’s guidelines.
3. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.

PART 3- EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide 1/4-inch (6.4-mm), annular clear space between sleeve and pathway or cable unless sleeve seal is to be installed, or unless seismic criteria require different clearance.

4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel, cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between pathway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at pathway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 270544

SECTION 271100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

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. Contractor is responsible for providing and installing Data cabinet/racks and equipment room fittings shown on plans and listed below, that meets or exceeds the specifications listed below.

1.2 SUMMARY

A. Section Includes:

1. Telecommunications mounting elements.
2. Backboards.
3. Telecommunications equipment racks and cabinets.
4. Grounding.

B. Related Requirements:

1. Section 27 0536 "Cable Trays for Communications Systems" for cable trays and accessories.
2. Section 27 1300 "Communications Backbone Cabling" for voice and data cabling associated with system panels and devices.
3. Section 27 1500 "Communications Horizontal Cabling" for voice and data cabling associated with system panels and devices.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. LAN: Local area network.

C. RCDD: Registered Communications Distribution Designer.

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 equipment racks and cabinets.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For communications equipment room fittings. 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. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of RCDD, RCDD/NTS, Commercial Installer, and Level 2 installer.
2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, or, Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Field Inspector: Currently registered by BICSI as RCDD, Commercial Installer Level 2, to perform the on-site inspection.

1.6 QUALIFICATIONS

A. Communications Cabling: The Contractor shall have (5) five years of documented experience performing cable placement, splicing, termination, connecting, and testing for each of the media types and (3) three years of applicable experience with the proposed system manufacturer. In the case of newer technologies that do not have a (3) three year history, the Contractor shall have documented experience for at least half of the lifetime of the new technology. The approved contractor shall, at a minimum, maintain a ratio of one manufacturer or BICSI certified installer for every two non-certified installers assigned to the project.

B. The contractor shall have on staff a BICSI Certified RCDD as a permanent employee. This staff member shall have been on staff for a minimum of (1) one year prior to the date of this projects release for bid.

C. The contractor shall have on staff at least (1) one BICSI Certified Technician and this staff member shall have been a full time employee for no less than (1) one year prior to the date of this projects release for bid. A BICSI Certified Technician shall be employed as the on-site Field Supervisor for this project.

D. The contractor shall provide resumes for the Project Manager, Supervisors and any skilled technicians or installers. Each resume shall include applicable certification documents provided by the manufacturer or BICSI.

1. Project Manager, Supervisors, and Principal Skilled Technicians: minimum of (5) five years' experience in like work.
2. Category 6 Unshielded Twisted Pair and Fiber Optic Cable Technicians: documented training, licensing, and/or certification for the types of media specified, as applicable as well as certification from the manufacturer of the solution chosen by the owner.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, field inspector and company. The contractor shall provide resumes for the Project Manager, Supervisors and any skilled technicians or installers. Each resume shall include applicable certification documents provided by the manufacturer or BICSI.

1. Project Manager, installation supervisor, and Principal Skilled Technicians: As a minimum be required to have no less than (5) five years' experience in like work.
2. The Company/Contractor proposing shall provide historical data confirming the company has a minimum of (5) five years applicable experience.
3. The Company/Contractor shall have a minimum of (3) three projects of similar size and type within the last (2) years. References for all submitted projects are required to assist with the evaluation.

B. Category 6 Unshielded Twisted Pair and Fiber Optic Cable Technicians: Documented training, licensing, and/or certification for the types of media specified, as applicable as well as certification from the manufacturer of the solution chosen by the owner.

C. Source quality-control reports.

D. Field quality-control reports.

E. Seismic Qualification Certificates: For equipment frames 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. Base certification on the maximum number of components capable of being mounted in each rack type. Identify components on which certification is based.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

PART 2- PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Equipment frames shall withstand the effects of earthquake motions determined according to ASCE/SEI 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 and the unit will be fully operational after the seismic event."

2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches, (19 by 1220 by 2440 mm). Comply with requirements for plywood backing panels specified in Section 06 1000 "Rough Carpentry." Use fire rated plywood. Paint all sides with two coats of fire retardant paint. Do not paint over plywood rating stamp.

2.3 EQUIPMENT FRAMES

A. Manufacturers: Subject to compliance with requirements, 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:

1. Chatsworth Products
2. Legrand
3. Owner and Consultant Approved Equal

B. General Frame Requirements:

1. Distribution Frames: Freestanding and wall-mounting, modular-steel units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
2. Module Dimension: Width compatible with EIA 310-D standard, 19-inch (480-mm) panel mounting.
3. Finish: Manufacturer's standard, baked-polyester powder coat.

C. Floor-Mounted Racks: Modular-type, steel or aluminum construction.

1. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug and a power strip.
2. Baked-polyester powder coat finish.
3. 2 or 4 post configuration as per plans.

D. Modular Freestanding Cabinets:

1. Removable and lockable side panels.
2. Hinged and lockable front and rear doors.
3. Adjustable feet for leveling.
4. Screened ventilation openings in the roof and rear door.
5. Cable access provisions in the roof and base.
6. Grounding bus bar.
7. Rack, or Roof-mounted, 550-cfm (260-L/s) fan with filter.
8. Power strip.
9. Baked-polyester powder coat finish.
10. All cabinets keyed alike.

E. Modular Wall Cabinets:

1. Wall mounting.
2. Steel, Aluminum Steel or aluminum construction.
3. Treated to resist corrosion.
4. Lockable front and rear doors.
5. Louvered side panels.
6. Cable access provisions top and bottom.
7. Grounding lug.
8. Rack, Roof-mounted, 250-cfm (118-L/s) fan.
9. Power strip.
10. All cabinets keyed alike.

F. Cable Management for Equipment Frames: (Vertical and Horizontal)

1. Integral wire retaining fingers.
2. Baked-polyester powder coat finish.
3. Vertical cable management panels shall have front and rear channels, with covers.
4. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each.

2.4 POWER STRIPS

A. Power Strips: Comply with UL 1363.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Rack mounting.
3. Six, 15-A, 120-V ac, NEMA WD 6, Configuration 5-15R, 20-A, 120-V ac, NEMA WD 6, Configuration 5-20R receptacles.
4. LED indicator lights for power and protection status.
5. LED indicator lights for reverse polarity and open outlet ground.
6. Circuit Breaker and Thermal Fusing: When protection is lost, circuit opens and cannot be reset.
7. Circuit Breaker and Thermal Fusing: Unit continues to supply power if protection is lost.
8. Close-coupled, direct plug-in. Cord connected with 15-foot (4.5-m) line cord.
9. Rocker-type on-off switch, illuminated when in on position.
10. Peak Single-Impulse Surge Current Rating: 33 kA per phase.
11. Protection modes shall be line to neutral, line to ground, and neutral to ground. UL 1449 clamping voltage for all three modes shall be not more than 330 V.

2.5 GROUNDING

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Telecommunications Main Bus Bar:

1. Connectors: Mechanical type, cast silicon bronze, solderless, compression exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
2. Ground Bus Bar: Copper, minimum 1/4 inch thick by 4 inches wide, (6 mm thick by 100 mm wide), with 9/32-inch, (7.14-mm), holes spaced 1-1/8 inches, (28 mm), apart.
3. Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

C. Comply with J-STD-607-A.

2.6 LABELING

A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers. Admin class 4.

PART 3- EXECUTION

3.1 ENTRANCE FACILITIES

A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and an enclosed housing when so directed by service provider.

B. Comply with requirements in Section 270528 "Pathways for Communications Systems" for materials and installation requirements for underground, buried and aerial pathways.

3.2 INSTALLATION

A. Comply with NECA 1.

B. Comply with BICSI TDMM for layout and installation of communications equipment rooms.

C. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

D. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.

1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
2. Record agreements reached in meetings and distribute them to other participants.
3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.
4. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.

E. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

3.3 SLEEVE AND SLEEVE SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 27 0544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.4 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-B; Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.5 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with J-STD-607-A.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

1. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

3.6 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements in Section 260553 "Identification for Electrical Systems."

B. Comply with requirements in Section 099123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for all Class 4 level of administration, including optional identification requirements of this standard.

D. Labels shall be preprinted or computer-printed type.

END OF SECTION 271100

SECTION 271300 - COMMUNICATIONS BACKBONE CABLING

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. Contractor is responsible for providing and installing a complete “turn-key” Backbone Cabling Infrastructure system that meets or exceeds the specifications listed below.

1.2 SUMMARY

A. Section Includes:

1. Pathways.
2. UTP cable – 25 pair copper
3. Fiber Optic Cable – 12/6 (12 strands OM4 and 6 strands of OS2)
4. Cable connecting hardware, patch panels, and cross-connects.
5. Cabling identification products.

B. Related Sections:

1. Section 27 0536 “ Cable trays for Communication Systems”
2. Section 27 1500 “ Communications Horizontal Cabling”

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. EMI: Electromagnetic interference.

D. IDC: Insulation displacement connector.

E. LAN: Local area network.

F. RCDD: Registered Communications Distribution Designer.

G. UTP: Unshielded twisted pair.

1.4 BACKBONE CABLING DESCRIPTION

A. Backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations and patch cords or jumpers used for backbone-to-backbone cross-connection.

B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

1.5 PERFORMANCE REQUIREMENTS

A. General Performance: Backbone cabling system shall comply with transmission standards in TIA/EIA-568-B.1, when tested according to test procedures of this standard.

1.6 ACTION SUBMITTALS

A. Product Data: Submit for each type of product indicated.

B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
3. Cabling administration drawings and printouts.
4. Wiring diagrams to show typical wiring schematics including the following:

    a. Cross-connects.
    b. Patch panels.
    c. Patch cords.

5. Cross-connects and patch panels. Detail mounting assemblies and show elevations and physical relationship between the installed components.
6. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical and mechanical elements. Include the following:

    a. Vertical and horizontal offsets and transitions.
    b. Clearances for access above and to side of cable trays.
    c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
    d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

1.7 CLOSEOUT SUBMITTALS

A. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.8 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. Patch-Panel Units: One of each type.
2. Connecting Blocks: One of each type.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff. (submit qualifications)

1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings, Cabling Administration Drawings and field testing program development by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of a Registered Technician, or Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

C. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

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. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.

F. Grounding: Comply with ANSI-J-STD-607-A.

1.10 QUALIFICATIONS

A. Communications Cabling: The Contractor shall have (5) five years of documented experience performing cable placement, splicing, termination, connecting, and testing for each of the media types and (3) three years of applicable experience with the proposed system manufacturer. In the case of newer technologies that do not have a (3) three year history, the Contractor shall have documented experience for at least half of the lifetime of the new technology. The approved contractor shall, at a minimum, maintain a ratio of one manufacturer or BICSI certified installer for every two non-certified installers assigned to the project.

B. The contractor shall have on staff a BICSI Certified RCDD as a permanent employee. This staff member shall have been on staff for a minimum of (1) one year prior to the date of this projects release for bid.

C. The contractor shall have on staff at least (1) one BICSI Certified Technician and this staff member shall have been a full time employee for no less than (1) one year prior to the date of this projects release for bid. A BICSI Certified Technician shall be employed as the on-site Field Supervisor for this project.

D. The contractor shall provide resumes for the Project Manager, Supervisors and any skilled technicians or installers. Each resume shall include applicable certification documents provided by the manufacturer or BICSI.

1. Project Manager, Supervisors, and Principal Skilled Technicians: minimum of (5) five years' experience in like work.
2. Category 6 Unshielded Twisted Pair and Fiber Optic Cable Technicians: documented training, licensing, and/or certification for the types of media specified, as applicable as well as certification from the manufacturer of the solution chosen by the owner.

1.11 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, field inspector and company. The contractor shall provide resumes for the Project Manager, Supervisors and any skilled technicians or installers. Each resume shall include applicable certification documents provided by the manufacturer or BICSI.

1. Project Manager, installation supervisor, and Principal Skilled Technicians: As a minimum be required to have no less than (5) five years' experience in like work.
2. The Company/Contractor proposing shall provide historical data confirming the company has a minimum of (5) five years applicable experience.
3. The Company/Contractor shall have a minimum of (3) three projects of similar size and type within the last (2) years. References for all submitted projects are required to assist with the evaluation.

B. Category 6 Unshielded Twisted Pair and Fiber Optic Cable Technicians: Documented training, licensing, and/or certification for the types of media specified, as applicable as well as certification from the manufacturer of the solution chosen by the owner.

C. Source quality-control reports.

D. Field quality-control reports.

1.12 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical fiber flashlight or optical loss test set.
2. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices and connector, including the loss value of each. Retain test data and include the record in maintenance data.
3. Test each pair of UTP cable for open and short circuits.

1.13 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.14 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

1.15 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for two, (2), years.

B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two, (2), years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

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 PATHWAYS

A. General Requirements: Comply with TIA/EIA-569-A.

B. Cable Support: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.

1. Support brackets with cable tie slots for fastening Velcro to brackets.
2. Lacing bars, spools, J-hooks, and D-rings.
3. Straps and other devices.

C. Cable Trays:

1. Manufacturers: Subject to compliance with requirements, 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, (See section 27 0536 Cable trays for Communication Systems", for installation procedures):
2. Ladder Cable Trays: (inside the ER/TR's)

a. CPI
b. Owner and Consultant approved equal

3. Basket Cable Trays: (outside the ER/TR's)

a. CPI

b. Cablofil
c. Homaco
d. B-Line

4. Cable Tray Material: Metal, suitable for indoors, and protected against corrosion by electroplated zinc galvanizing, complying with ASTM B 633, Type 1, not less than 0.000472 inches (0.012 mm) thick. Hot-dip galvanizing, complying with ASTM A 123/A 123M, Grade 0.55, not less than 0.002165 inches (0.055 mm) thick.

a. Basket Cable Trays: 12 inches (305 mm), 18 inches, (457.2mm), wide and 4 inches (101.6 mm) deep. Wire mesh spacing shall not exceed 2 by 4 inches (50 by 100 mm), unless otherwise noted on plans.
b. Ladder Cable Trays: Nominally 12 inches (305 mm), 18 inches, (457.2mm), wide and a rung spacing of 12 inches (305 mm), unless otherwise noted on plans.

D. Conduit and Boxes: Comply with requirements in Section 260533 "Raceway and Boxes for Electrical Systems." Flexible metal conduit shall not be used.

1. Outlet boxes shall be no smaller than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.

2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches, (19 by 1220 by 2440 mm). Comply with requirements in Section 061000 "Rough Carpentry" for plywood backing panels. Paint all sides with two, (2), coats of fire retardant paint. Do not paint over plywood rating stamp.

2.3 UTP CABLE

A. Manufacturers: Subject to compliance with requirements, 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:

1. Berk-Tek
2. Superior Essex

B. Description: 100-ohm, Cat 3, 25 pair, (unless otherwise noted on plans), formed into 25-pair binder groups covered with a gray/black thermoplastic jacket and overall metallic shield, (metallic shield for outdoor/DB use only).

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-B.1 for performance specifications.
3. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types: Type requirements in subparagraphs below are minimum requirements and may be revised to suit Project. Retain options if "permitted substitutions," as defined in NFPA 70, are appropriate for this Project.
4. Communications, Limited Purpose: Type CMP, CMR, OSP, (Dependent on environmental conditions)

2.4 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, 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:

1. Leviton
2. Customer and consultant approved equal

B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

C. Connecting Blocks: 110-style IDC for Category 3 backbone. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

D. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: One for each conductor in assigned cables.

E. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

1. Number of Jacks per Field: One for each four-pair UTP cable indicated conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria.

F. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

G. Patch Cords: Factory-made, 4-pair cables in 36-inch (900-mm) and 48-inch1200-mm lengths; terminated with 8-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6A+ performance. Patch cords shall have latch guards to protect against snagging, (see section 27 1500-2.05-G), for cat6A+ patch cord requirements.
2. Patch cords shall have color-coded boots for circuit identification.

2.5 OPTICAL FIBER CABLE

A. Manufacturers: Subject to compliance with requirements, 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:

1. Corning
2. Berk-Tek
3. Owner and Consultant approved equal

B. Description: 12/6, 12 strands of OM4 and 6 strands of OS2 nonconductive, CMP, (indoor/outdoor, plenum rated, dependent on environmental conditions), tight buffer, optical fiber cable.

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA/EIA-568-B.3 for performance specifications.
3. Comply with TIA/EIA-492AAAA-Band TIA/EIA-492AAAA-A for detailed specifications.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

    a. Type requirements in first six subparagraphs below are minimum requirements and may need to be revised to suit Project. OFC, OFCR, OFCG, and OFCP are conductive optical fiber cables that might have application in industrial settings. Retain options if "permitted substitutions," as defined in NFPA 70, are appropriate for this Project.
    b. Maximum Attenuation (dB) / km 3.5 @ 850nm / 1.5 @ 1300nm, OM 4. 0.65db/km @1310nm, 0.65db/km @ 1383nm, 0.50db/km @1550nm, OS 2
    c. Minimum Modal Bandwidth OFL (MHz x km) 2000 @ 850nm / 500 @ 1300nm, OM 4. 1310, 1383, 1550 OS 2

C. Jacket:

1. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-B.
2. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches (1000 mm).

2.6 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, 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:

1. Corning
2. Berk-Tek
3. Owner and Consultant approved equal

B. LIU’s: Modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

C. Patch Cords: Factory-made, dual-fiber cables in 2 meter lengths.

D. Cable Connecting Hardware:

1. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.
2. Quick-connect, simplex and duplex, Type LC connectors. Insertion loss not less than 0.5 db.

3. Type SFF connectors may be used in termination racks, panels, and equipment packages.

2.7 GROUNDING

A. Comply with requirements in Section 26 0526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Comply with ANSI-J-STD-607-A.

2.8 IDENTIFICATION PRODUCTS

A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.9 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test cables on reels according to TIA/EIA-568-B.1.

C. Factory test UTP cables according to TIA/EIA-568-B.2.

D. Factory test multimode optical fiber cables according to TIA/EIA-526-14-A and TIA/EIA-568-B.3.

E. Cable will be considered defective if it does not pass tests and inspections. Cable that does not pass test and inspections shall be replaced.

F. Prepare test and inspection reports.

PART 3 -EXECUTION

3.1 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider. All Copper Building entrance, (feed), cable shall be installed with fused protection.

1. Manufacturers: Subject to compliance with requirements, 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:

a. Circa
b. Owner and Consultant approved equal

3.2 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks and counters and except in accessible ceiling spaces, in attics, and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Section 26 0533 "Raceway and Boxes for Electrical Systems."

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 INSTALLATION OF PATHWAYS

A. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A.

B. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Section 271100 "Communications Equipment Room Fittings." Drawings indicate general arrangement of pathways and fittings.

C. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.

D. Comply with requirements in Section 26 0533 "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.

E. Install manufactured conduit sweeps and long-radius elbows whenever possible.

F. Pathway Installation in Communications Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard when entering room from overhead.
4. Extend conduits 3 inches, (76 mm), above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

G. Backboards: Install backboards with 96-inch (2440-mm) dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints. Backboards shall be fire rated and all sides painted with 2 coats of fire retardant paint.

3.4 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.

4. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
5. Cables may not be spliced, (except for Fiber in the ER/TR's). Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
6. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
9. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
10. In the communications equipment room, install a 10-foot, (3-m-), long service loop on each end of cable.
11. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-B.2.
2. Do not untwist UTP cables more than 1/4 inch, (6.35mm), from the point of termination to maintain cable geometry.

D. Optical Fiber Cable Installation:

1. Comply with TIA/EIA-568-B.3.
2. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway, a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 60 inches, (1524 mm), apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

F. Group connecting hardware for cables into separate logical fields.

G. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches, (127 mm).
b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches, (300 mm).
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches, (610 mm).

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches, (64 mm).
b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches, (150 mm).
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches, (300 mm).

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches, (76 mm).
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches, (150 mm).

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches, (1200 mm).
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches, (127 mm).

3.5 FIRESTOPPING

A. Comply with requirements in Section 07 8413 "Penetration Firestopping."

B. Comply with TIA/EIA-569-A; Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.6 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI-J-STD-607-A.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch, (50-mm), clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.7 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."

1. Administration Class: 4.
2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Comply with requirements in Section 09 9123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 4 level of administration including optional identification requirements of this standard.

D. Comply with requirements in Section 27 1500 "Communications Horizontal Cabling" for cable and asset management software.

E. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

F. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways and equipment grounding conductors.

G. Cable and Wire Identification:

1. Label each cable within 4 inches, (100 mm), of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet, (4.5 m).
4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

    a. Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device with a name and number of a particular device as shown.
    b. Label each unit and field within distribution racks and frames.

5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware.

Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

H. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA 606-A, for the following:

1. Cables; use flexible vinyl or polyester that flexes as cables are bent.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Visually inspect UTP and optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-B.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test UTP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

    a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

4. Optical Fiber Cable Tests:

    a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
    b. Link End-to-End Attenuation Tests:

        1) Horizontal and singlemode backbone link measurements: Test at 1310 or 1550 nm in 1 direction according to TIA/EIA-526-14-A, Method B, and One Reference Jumper.
        2) Attenuation test results for backbone links shall be less than 2.0 db. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-B.1.

D. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

E. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

F. End-to-end cabling will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

3.9 SYSTEM WARRANTY

A. Contractor shall perform all labeling requirements and provide testing documentation for verification as described herein.

B. Contractor shall submit cable records to reflect all moves, adds, and changes.

C. Contractor shall provide site plans showing locations of all telecommunication routes. See Item 3.06.

D. Contractor shall submit final paperwork for warranty to manufacturer and a copy to the Owner one week prior to the substantial completion date.

E. Contractor must be a certified as required by the owner and approved solution supplier such as Mohawk, Berk-Tek, Ortronics, and Siemens.

F. Contractor must offer a minimum 20-year extended manufacturer’s warranty for the premises fiber cabling solution comprised of approved manufacturer products and must follow all warranty registration procedures set forth by the manufacturer, including submitting all required documentation to the manufacturer for warranty certification.

G. All installed equipment must conform to the manufacturer's official published specifications. The warranty shall begin at the system acceptance date and remain in effect for a period of 20 years (minimum) from that date. The contractor shall agree to repair, adjust, and/or replace, as determined by the owner and to replace defective equipment, materials, or other parts of the system at the contractor's sole cost. Owner will incur no costs for service or replacement of parts during the warranty period of 20 years. All third party warranties shall be passed through from the contractor to the owner.

H. Contractor shall warrant that the system will function as specified in the approved manufacturer's Technical Description Guide.

I. Contractor shall warrant that the system shall accommodate the specifications in all appropriate sections of this Request for Proposal and all applicable sections of the owners Specifications.

END OF SECTION 271300

SECTION 271500 - COMMUNICATIONS HORIZONTAL CABLING

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. Contractor is responsible for providing and installing a complete “turn-key” Category 6 Infrastructure Cabling system that meets or exceeds the specifications listed below.

1.2 SUMMARY

A. Section Includes:

1. UTP cabling, (Category 6).
2. Multiuser telecommunications outlet assemblies.
3. Cable connecting hardware, patch panels and cross-connects.
4. Telecommunications outlet/connectors.
5. Cabling system identification products.
6. Cable management system.

B. Related Requirements:

1. Section 27 1300 "Communications Backbone Cabling" for voice and data cabling associated with system panels and devices.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. EMI: Electromagnetic interference.

D. IDC: Insulation displacement connector.

E. LAN: Local area network.

F. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.

G. RCDD: Registered Communications Distribution Designer.

H. UTP: Unshielded twisted pair.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordinate layout and installation of telecommunications cabling with Owner's telecommunications and LAN equipment and service suppliers.

B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
3. Cabling administration drawings and printouts.
4. Wiring diagrams to show typical wiring schematics, including the following:

    a. Cross-connects.
    b. Patch panels.
    c. Patch cords.

5. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.

C. Samples: For workstation outlets, jacks, jack assemblies, in specified finish, one for each size and outlet configuration and faceplates for color selection and evaluation of technical features.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For splices and connectors to include in maintenance manuals.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. 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. Patch-Panel Units: One of each type.
2. Connecting Blocks: One of each type.
3. Device Plates: One of each type.
4. Multiuser Telecommunications Outlet Assemblies: One of each type.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, or Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.9 QUALIFICATIONS

A. Communications Cabling: The Contractor shall have (5) five years of documented experience performing cable placement, splicing, termination, connecting, and testing for each of the media types and (3) three years of applicable experience with the proposed system manufacturer. In the case of newer technologies that do not have a (3) three year history, the Contractor shall have documented experience for at least half of the lifetime of the new technology. The approved contractor shall, at a minimum, maintain a ratio of one manufacturer or BICSI certified installer for every two non-certified installers assigned to the project.

B. The contractor shall have on staff a BICSI Certified RCDD as a permanent employee. This staff member shall have been on staff for a minimum of (1) one year prior to the date of this projects release for bid.

C. The contractor shall have on staff at least (1) one BICSI Certified Technician and this staff member shall have been a full time employee for no less than (1) one year prior to the date of this projects release for bid. A BICSI Certified Technician shall be employed as the on-site Field Supervisor for this project.

D. The contractor shall provide resumes for the Project Manager, Supervisors and any skilled technicians or installers. Each resume shall include applicable certification documents provided by the manufacturer or BICSI.

1. Project Manager, Supervisors, and Principal Skilled Technicians: minimum of (5) five years' experience in like work.
2. Category 6 Unshielded Twisted Pair and Fiber Optic Cable Technicians: documented training, licensing, and/or certification for the types of media specified, as applicable as well as certification from the manufacturer of the solution chosen by the owner.

1.10 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, field inspector and company. The contractor shall provide resumes for the Project Manager, Supervi-

sors and any skilled technicians or installers. Each resume shall include applicable certification documents provided by the manufacturer or BICSI.

1. Project Manager, installation supervisor, and Principal Skilled Technicians: As a minimum be required to have no less than (5) five years' experience in like work.

2. The Company/Contractor proposing shall provide historical data confirming the company has a minimum of (5) five years applicable experience.

3. The Company/Contractor shall have a minimum of (3) three projects of similar size and type within the last (2) years. References for all submitted projects are required to assist with the evaluation.

B. Category 6 Unshielded Twisted Pair and Fiber Optic Cable Technicians: Documented training, licensing, and/or certification for the types of media specified, as applicable as well as certification from the manufacturer of the solution chosen by the owner.

C. Source quality-control reports.

D. Field quality-control reports.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test optical fiber cables to determine the continuity of the strand end to end. Use optical fiber flashlight or optical loss test set.
2. Test optical fiber cables while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector; including the loss value of each. Retain test data and include the record in maintenance data.
3. Test each pair of UTP cable for open and short circuits.

PART 2- PRODUCTS

2.1 HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called a "permanent link," a term that is used in the testing protocols.

1. TIA/EIA-568-B.1 requires that a minimum of two telecommunications outlet/connectors be installed for each work area.
2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
3. Bridged taps and splices shall not be installed in the horizontal cabling.
4. Splitters shall not be installed as part of the optical fiber cabling.

B. A work area is approximately 100 sq. ft., (9.3 sq. m), and includes the components that extend from the telecommunications outlet/connectors to the station equipment.

C. The maximum allowable horizontal cable length is 295 feet, (90 m). This maximum allowable length does not include an allowance for the length of 16 feet, (4.9 m), to the workstation equipment or in the horizontal cross-connect.

2.2 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA/EIA-568-B.1 when tested according to test procedures of this standard.

B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

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. Grounding: Comply with J-STD-607-A.

2.3 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches, (19 by 1220 by 2440 mm). Comply with requirements in Section 061000 "Rough Carpentry" for plywood backing panels.

2.4 UTP CABLE

A. Manufacturers: Subject to compliance with requirements, 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:

1. Berk-Tek LANmark Category 6 (blue in color)
2. Owner and consultant Approved equal

B. Description: 100-ohm, four-pair UTP, covered with a blue thermoplastic jacket.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-B.1 for performance specifications.
3. Comply with TIA/EIA-568-B.2 Category 6A.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

    a. Communications, Plenum Rated: Type CMP, complying with NFPA 262.

2.5 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, 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:

1. Leviton category 6 (Blue in color)
2. Owner and consultant approved equal

B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

C. Cat 6 Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

1. Number of Jacks per Field: One for each four-pair UTP cable indicated conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria.

D. Cat 6 Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

E. Patch Panels:

1. Leviton Category 6
2. Owner and consultant approved equal

F. Patch Cords: Factory-made, (of same cabling solution manufacturer), four-pair cables; terminated with eight-position modular plug at each end.

G. Manufactures:

1. Berk-Tek – 5’ length
2. Berk-Tek – 10’ length.
3. Customer and consultant approved equal.
4. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
5. Patch cords shall have color-coded boots for circuit identification.

2.6 TELECOMMUNICATIONS OUTLET/CONNECTORS

A. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA/EIA-568-B.1.

B. Workstation Outlets; Four-port-connector assemblies mounted in single or multi-gang faceplate.

1. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."
2. Metal Faceplate: Stainless steel, Brass, complying with requirements in Section 262726 "Wiring Devices."
3. For use with snap-in jacks accommodating any combination of UTP, optical fiber, and coaxial work area cords.

    a. Flush mounting inserts, Blue in color.

4. Legend: Factory labeled by silk-screening or engraving for stainless steel or brass faceplates.
5. Legend: Machine printed, in the field, using adhesive-tape label.
6. Legend: Snap-in, clear-label covers and machine-printed paper inserts.

2.7 GROUNDING

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Comply with J-STD-607-A.

2.8 IDENTIFICATION PRODUCTS

A. Comply with TIA/EIA-606-A and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Comply with requirements in Section 26 0553 "Identification for Electrical Systems."

2.9 CABLE MANAGEMENT SYSTEM

A. Manufacturers: Subject to compliance with requirements, 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:

1. iTRACS Corporation, Inc.
2. TelSoft Solutions.

B. Description: Computer-based cable management system, with integrated database and graphic capabilities.

C. Document physical characteristics by recording the network, TIA/EIA details, and connections between equipment and cable.

D. Information shall be presented in database view, schematic plans, or technical drawings.

1. Microsoft Visio Professional or AutoCAD drawing software shall be used as drawing and schematic plans software.

E. System shall interface with the following testing and recording devices:

1. Direct upload tests from circuit testing instrument into the personal computer.
2. Direct download circuit labeling into labeling printer.

2.10 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-B.1.

C. Factory test UTP cables according to TIA/EIA-568-B.2.

D. Factory test multimode optical fiber cables according to TIA-526-14-A and TIA/EIA-568-B.3.

E. Cable will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

PART 3- EXECUTION

3.1 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

A. Install cables in pathways and cable trays except within consoles, cabinets, desks and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal pathways and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements in Section 270528 "Pathways for Communications Systems."
3. Comply with requirements in Section 270536 "Cable Trays for Communications Systems."

B. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures:

1. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
2. Install lacing bars and distribution spools.
3. Install conductors parallel with or at right angles to sides and back of enclosure.

3.3 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
5. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches, (760 mm) and not more than 6 inches, (150 mm), from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
6. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.

8. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
9. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
10. In the communications equipment room, install a 10-foot, (3-m), long service loop on each end of cable.
11. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-B.2.
2. Do not untwist UTP cables more than 1/4 inch (6.35 mm) from the point of termination to maintain cable geometry.

D. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway a minimum of 8 inches, (200 mm), above ceilings by cable supports not more than 60 inches, (1524 mm), apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

E. Group connecting hardware for cables into separate logical fields.

F. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-B for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (610 mm).

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (76 mm).
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.4 FIRESTOPPING

A. Comply with requirements in Section 07 8413 "Penetration Firestopping."

B. Comply with TIA-569-B; Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.5 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding and Electrical Protection" Chapter.

B. Comply with J-STD-607-A.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch, (50-mm), clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.6 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."

1. Administration Class: 4, TIA/EIA-606-A.
2. Color-code cross-connect fields. Apply colors to voice and data service backboards, connections, covers, and labels.

B. Using cable management system software specified in Part 2, develop Cabling Administration Drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable and label cable, jacks, connectors, and terminals to which it connects

with same designation. At completion, cable and asset management software shall reflect as-built conditions.

C. Comply with requirements in Section 09 9123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

D. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 4 level of administration, including optional identification requirements of this standard.

E. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

F. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of TIA/EIA-606-A. Furnish electronic record of all drawings, in software and format selected by Owner.

G. Cable and Wire Identification:

1. Label each cable within 4 inches, (100 mm), of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet, (4.5 m).
4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

    a. Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device, shall be identified with name and number of particular device as shown.
    b. Label each unit and field within distribution racks and frames.

5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

H. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA-606-A.

1. Cables use flexible vinyl or polyester that flex as cables are bent.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: 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. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-B.1.
2. Visually confirm Category 6 marking of outlets, cover plates, outlet/connectors and patch panels.
3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
4. Test UTP backbone copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

    a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments, (Normative)," Annex, complying with measurement accuracy specified in "Measurement Accuracy, (Informative)," Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

5. UTP Performance Tests:

    a. Test for each outlet and MUTOA. Perform the following tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.2:

        1) Wire map.
        2) Length (physical vs. electrical, and length requirements).
        3) Insertion loss.
        4) Near-end crosstalk (NEXT) loss.
        5) Power sum near-end crosstalk (PSNEXT) loss.
        6) Equal-level far-end crosstalk (ELFEXT).
        7) Power sum equal-level far-end crosstalk (PSELFEXT).
        8) Return loss.
        9) Propagation delay.
        10) Delay skew.

6. Final Verification Tests: Perform verification tests for UTP and optical fiber systems after the complete communications cabling and workstation outlet/connectors are installed.

    a. Voice Tests: These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.
    b. Data Tests: These tests assume the Information Technology Staff has a network installed and is available to assist with testing. Connect to the network interface

device at the demarcation point. Log onto the network to ensure proper connection to the network.

D. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.8 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for two, (2), years.

B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two, (2), years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

1. Provide thirty, (30), days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel in cable-plant management operations, including changing signal pathways for different workstations, rerouting signals in failed cables and keeping records of cabling assignments and revisions when extending wiring to establish new workstation outlets. Include training in cabling administration software.

3.10 SYSTEM WARRANTY

A. Contractor shall perform all labeling requirements and provide testing documentation for verification as described herein.

B. Contractor shall submit cable records to reflect all moves, adds, and changes.

C. Contractor shall provide site plans showing locations of all telecommunication routes. See Item 3.06.

D. Contractor shall submit final paperwork for warranty to manufacturer and a copy to the Owner one week prior to the substantial completion date.

E. Contractor must be a certified as required by the owner and approved solution supplier such as Mohawk, Berk-Tek, Ortronics, and Siemens.

F. Contractor must offer a minimum 20-year extended manufacturer’s warranty for the premises fiber cabling solution comprised of approved manufacturer products and must follow all warranty registration procedures set forth by the manufacturer, including submitting all required documentation to the manufacturer for warranty certification.

G. All installed equipment must conform to the manufacturer's official published specifications. The warranty shall begin at the system acceptance date and remain in effect for a period of 20 years (minimum) from that date. The contractor shall agree to repair, adjust, and/or replace, as determined by the owner and to replace defective equipment, materials, or other parts of the system at the contractor's sole cost. Owner will incur no costs for service or replacement of parts during the warranty period of 20 years. All third party warranties shall be passed through from the contractor to the owner.

H. Contractor shall warrant that the system will function as specified in the approved manufacturer's Technical Description Guide.

I. Contractor shall warrant that the system shall accommodate the specifications in all appropriate sections of this Request for Proposal and all applicable sections of the owners Specifications.

END OF SECTION 271500

SECTION 28 10 0
ACCESS CONTROL/ VIDEO SURVEILLANCE/ DISPATCH
(SEE ALLOWANCES)

PART 1 – GENERAL

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS SECURITY ACCESS CONTROL SYSTEM

A. Klein Security & safety: A Klein Automation & Electric company

2.02 SYSTEM DESCRIPTION

A. Scope of Work:
   1. The Security Access Control System shall be that of Klein Security & Safety Systems in order to maintain compatibility of the existing systems in use by the City of Lovington Fire Department. This will provide consistency in the system components and software, alleviating the need for the Lovington Fire Department to learn new systems and maintain multiple technologies within their facilities.

2.03 EQUIPMENT

- (8) Multiclass Card Readers, Seven of which are to be mullion-mounted at the doors as indicated on the construction documents, One of which is to be mounted on a pedestal at the entrance gate
- (1) Card Reader Pedestal at the entrance gate
- (1) Access Control Panel, Eight reader-ports with integral door control relays, system power supplies, and battery back-up. This control panel will be located in the Comm Room 133.
- (1) Network Interface Card, capable of communicating over the City's wide area network and with the existing access control database located at the City's public safety facility.
- (8) Door Status Switches, connected to the access control panel and utilized to monitor door status (open/closed) and report to the dispatch center
- (1) Lot Access Control Cabling

2.04 CLARIFICATIONS/ ASSUMPTIONS

A. Electric door hardware will be provided and installed by the door hardware provider and shall include electric locks, electric hinges, electrified panic devices, and power supplies necessary to activate the electrified hardware. Connection and integration of the electrified hardware will be by Klein Security & Safety.

B. Gate and gate operator will be furnished and installed by others. Connection of the security access control system to the gate operator will be by Klein Security & Safety.

C. ADA operators and associated operator activation buttons will be furnished and installed by others. Integration of the ADA operators to the security access control system will be by Klein Security & Safety.

D. All security access control systems pathways, 120VAC power, and device back-box rough-in will be by others. Klein Security & Safety will furnish and install low-voltage cabling to the security access control system devices.

2.05 ACCEPTABLE MANUFACTURER: VIDEO SURCEILLANCE SYSTEM

A. Klein Security & safety: A Klein Automation & Electric company

2.06 SYSTEM DESCRIPTION

A. Scope of Work:

1. The Video Surveillance System shall be that of Klein Security & Safety Systems in order to maintain compatibility of the existing systems in use by the City of Lovington Fire Department. This will provide consistency in the system components and software, alleviating the need for the Lovington Fire Department to learn new systems and maintain multiple technologies within their facilities.

2. The video surveillance system shall be an IP-based system, utilizing a network of CAT6 cabling to be installed in the facility. As indicated on the construction documents, the CAT6 cabling and associated terminating devices for the video surveillance system is to be furnished and installed by the electrical contractor and their data communications team.

2.07 EQUIPMENT

- (7) Outdoor, Bullet-Style Cameras, 3 Megapixel, Infrared Capable, Vari-focal Lens 3-10.5mm
  - Locations as indicated on the construction documents
- (4) Indoor, Bullet-Style Cameras, 3 Megapixel, Infrared Capable, Vari-focal Lens 3-10.5mm
  - Locations in the four corners of the apparatus bays
- (10) Indoor, Dome-Style Cameras, 3 Megapixel, Fixed focus lens 1.8mm, Digital PTZ, Selectable Corridor Format Views
- (1) Power-over-ethernet switch, Layer -3, managed, Gigabit
- (1) Network video server, 7 Terabyte storage capable, 8 GB Ram, loaded with Server 2012 and twenty-one camera licenses
- (1) 43” LED 4K Monitor with Wall Mount.

2.08 CLARIFICATIONS

A. All video surveillance system pathways, CAT6 cabling and terminations, 120VAC power, and device back-box rough-in will be by others

B.

2.09 ACCEPTABLE MANUFACTURER: DISPATCH SYSTEM

A. US DIGITAL DESIGNS, Tempe, Arizona USA

2.10 EQUIPMENT

A. Phoenix G2 – Automated Fire Station Alerting
B. See Attached US Digital Designs Proposal NM_LOVI002

PART 3 – EXECUTION

END OF SECTION 28 10 00

US DIGITAL DESIGNS

Tempe, Arizona USA

Phoenix G2 - Automated Fire Station Alerting

Quotation to:

City of Lovington, New Mexico
for Lovington Fire Department

Project:

G2 Fire Station Alerting System

x2 Dispatch Systems (Primary & Backup) / x1 Station System (New FS02)

Proposal number:

NM_LOVI001

Revision #

1

BIDDING CONTRACTOR KIT/ALLOWANCE'. Turnkey System Quote to be provided by city to bidding contractors for inclusion as allowance in their construction of New Station 02 bid reponses - All inquiries/communications from contractors must be through city only (not to USDD)

[Pricing per Public Procurement Authority (PPA), Master Price Agreement (MPA) and available to members of National Purchase Partners, LLC dba FireRescueGPO, dba Public Safety GPO, dba Law Enforcement GPO and dba NPPGov - more information available at https://www.nppgov.com/vendors/us-digital-designs/ - **Lovington is Member # 034871**]

Quote Date:

20-Apr-2017

Quote Expires:

19-Jul-2017

FOR FINAL INSTALLATION CONTACT:

Kirkmeyer Electric, Inc.

Conner McReynolds / kirkmeyer1909@gmail.com

By:

Erik Hanson
Project Manager

US Digital Designs, Inc.
1835 E Sixth St #27
Tempe, AZ 85281
602-687-1739 direct
480-290-7892 fax
ehanson@usdd.com

[This Proposal is subject to corrections due to Errors or Omissions]

US DIGITAL DESIGNS

1835 E. Sixth St. Suite #27
Tempe, Arizona 85281
877-551-8733 tel *480-290-7892 fax*

QUOTE

DATE: **4/20/17**
Expires: **7/19/17**

Quote SUBMITTED TO:
City of Lovington, New Mexico
for Lovington Fire Department

REF PROPOSAL	
NM_LOVI001 v1	**DISPATCH-LEVEL**

PRIMARY DISPATCH G2 FSA SYSTEM

Dispatch center costs typically only need to be assumed once per dispatching agency, no matter how many stations are dispatched (unless redundant centers or further modifications are needed). Costs for this part of the system are often shared between consolidated agencies.

COMMUNICATIONS GATEWAY EQUIPMENT

Item	Unit	Mfr	Qty	Description	Part No.	US List Unit	QUOTE UNIT	QUOTE EXT	
D1a	PR	USDD	1	**G2 Communications Gateway Pair** (Hardware for CAD interface) 2@2RU each	G2-GW	$ 9,250.00	$ 8,325.00	$ 8,325.00	
D2	Kit	USDD	1	**Multi-Port Ethernet Interface Pair** (8 Ports Total) to support additional networks	MPE-8	$ 1,175.00	$ 1,057.50	$ 1,057.50	
D3a	Kit	USDD	1	**G2 Gateway Audio Radio Interface** (**GaRi**) - Rack Mount	GaRi-RM	$ 1,885.00	$ 1,696.50	$ 1,696.50	
D4	Kit	USDD	0	**G2 Gateway Audio Serial Interface** (**GaSi**)	GaSi	$ 1,440.00	$ 1,296.00	$ -	
D5	Kit	USDD	0	**G2 HDTV REMOTE** Module (TV & Electrical Outlet by Others)	TVR	$ 875.00	$ 787.50	$ -	
D6	Kit	USDD	0	**G2 Light Tower Interface**	LTI	$ 520.00	$ 468.00	$ -	

COMMUNICATIONS GATEWAY INTERFACES

Item	Unit	Mfr	Qty	Description	Part No.	US List Unit	QUOTE UNIT	QUOTE EXT	
D7	LOT	USDD	0	**Radio System Interface**	RSI	$13,650.00	$12,285.00	$ -	
D8	LOT	USDD	0	**Additional Radio Channel**	ARC	$ 4,225.00	$ 3,802.50	$ -	
D9	LOT	CAD	1	**CAD Interface** - **Cappers** (USDD-side Only - Customer responsibility to discuss CAD-side costs (if any) with their vendor)	PCAD-I	$10,890.00	$ 9,801.00	$ 9,801.00	

COMMUNICATIONS GATEWAY SERVICES

Item	Unit	Mfr	Qty	Description	Part No.	US List Unit	QUOTE UNIT	QUOTE EXT	
D10	HR	USDD	50	**Gateway Configuration & Modifications**	GW-CM	$ 280.00	$ 252.00	$ 12,600.00	
D11	LOT	USDD	0	**Radio System Interface Modification**	RSI-CM	$ 4,225.00	$ 3,802.50	$ -	
D12	LOT	USDD	1	**Gateway Installation and Start-up**	GW-ISU	$ 5,825.00	$ 5,242.50	$ 5,242.50	
D13	LOT	USDD	1	**Gateway Project Management**	GW-PM	$ 417.60	$ 375.84	$ 375.84	

D14a	LOT	USDD	**1**	**Training - System Administrator** - **On-Site** (4 Hours / Train-The-Trainer)	**TRA-SA-O**	$ 2,750.00	**$ 2,475.00**	**$ 2,475.00**	
D14b	LOT	USDD	**0**	**Training - System Administrator** - **Remote Refresh** (4 Hours / Train-The-Trainer)	**TRA-SA-R**	$ 1,200.00	**$ 1,080.00**	**$ -**	
D15a	LOT	USDD	**1**	**Training - Dispatch Operator** - **On-Site** (4 Hours / Train-The-Trainer)	**TRA-DO-O**	$ 2,750.00	**$ 2,475.00**	**$ 2,475.00**	
D15b	LOT	USDD	**0**	**Training - Dispatch Operator** - **Remote Refresh** (4 Hours / Train-The-Trainer)	**TRA-DO-R**	$ 1,200.00	**$ 1,080.00**	**$ -**	
D16a	LOT	USDD	**0**	**Training - Installation Contractor** - **On-Site** / USDD G2 Certification / (8 Hours / Train-The-Trainer (TBD - only needed if required to use non-certified contractor)	**TRA-IC-O**	$ 4,325.00	**$ 3,892.50**	**$ -**	
D16b	LOT	USDD	**0**	**Training - Installation Contractor** - **At Arizona Training Center** / USDD G2 Certification / 4 Hours / Train-The-Trainer (TBD - only needed if required to use non-certified contractor)	**TRA-IC-AZ**	$ 1,600.00	**$ 1,440.00**	**$ -**	
D17a	HR	USDD	**0**	Management Meeting with Customer / at USDD Tempe, AZ location (per Hour / Per Person)	**MTG-MGT-U**	$ 244.00	**$ 219.60**	**$ -**	
D17b	LOT	USDD	**0**	Management Meeting with Customer / at Customer Site (above per hour/per person cost + required travel and accomodation)	**MTG-MGT-C**	$ -	**$ -**	**$ -**	
D18	LOT	USDD	**0**	Misc Option 1		$ -	**$ -**	**$ -**	
D19	LOT	USDD	**0**	Misc Option 2		$ -	**$ -**	**$ -**	

PRIMARY DISPATCH G2 FSA SYSTEM	**System Total:**	**$ 44,048.34**
	Shipping Total:	**$ 126.00**
	System Subtotal	**$ 44,174.34**

PRIMARY DISPATCH MOBILE APP SERVICE

for IOS and ANDROID Platforms Only - In Conjunction with USDD Communications Gateways Only

For each year the FSA System is under standard warranty or elected recurring support coverage, USDD would like to offer our G2 Mobile Station Alerting App to those customers at no additional cost (in groups of 24 licenses-per-ATX-purchased).

# of Mobile App Device Licenses (Users) Requested:	**24**
# of Stations within the agency to be Alerted:	**1**
# of Stations to have ATX Station Controller Installed:	**1**

APP DEVICE LICENSES - INCLUDED (at no additional cost, x24 Per-ATX Installed while under Warranty/Support)

Item	Unit	Mfr	Qty	Description	Part No.	US List Unit	QUOTE UNIT	QUOTE EXT	
A1	Ea/Yr	USDD	**24**	G2 MOBILE FSAS APP - Single Device License / Per Year Cost ($9.00 / $8.10 per Month)	**G2-APP-DLI**	$ (108.00)	**$ (97.20)**	**-2332.8 but no cost/included while under warranty or elected support**	

APP DEVICE LICENSES - ADDITIONAL NEEDED (or surplus available)

Item	Unit	Mfr	Qty	Description	Part No.	US List Unit	QUOTE UNIT	QUOTE EXT	
A2	Ea/Yr	USDD	**0**	G2 MOBILE FSAS APP - Single Device License / Per Year Cost ($9.00 / $8.10 per Month)	**G2-APP-DLA**	$ 108.00	**$ 97.20**	**$ -**	

PRIMARY DISPATCH MOBILE APP SERVICE	**Yearly Total:**	**$ -**
	All Years Subtotal:	**$ -**

USDD G2 MOBILE FSA APP:

USDD has developed the Phoenix G2 FSA Mobile Application (the "App") to provide a remote extension of the customer's existing G2 FSAS. **Mobile App Only Available to Customers Using USDD's G2 Communications Gateways interfaced to a formal Computer Aided Dispatch (CAD) System**. The App is supported by Apple and Android devices. The App will interface with the Agency's CAD to send simultaneous mobile alerts, including dispatch announcements, administrative alerts, IT support notifications and application update notifications to authorized personnel via their smartphones and tablets. The App alerts personnel as individuals or groups (e.g., stations, battalions, districts, etc.) wherever they are, making it especially ideal for volunteers and reserves. The mobile alerts plays the same tones as those in the station, shows incident location using the device's built-in mapping capabilities and enables users to save notifications for future reference and search for previous notifications. In addition, the App provides an easy-access email address and phone link to local IT support. Each ATX Station Controller will enable x24 App licenses at no additional charge while the System is under warranty or annual service and support. Additional licenses can be obtained on a sliding cost scale. It should be noted, however, that the performance of mobile alerting is subject to network reliability and coverage.

So your eventual needs will be determined when you let us know how many device licenses you would need, versus the 24 devices-licenses-per-ATX-purchased and currently under warranty or support. As long as the purchased/installed ATX Station Controller is currently under warranty or elected recurring annual support, then there is no additional annual cost for up to x24 individual device licenses for the G2 Mobile FSA App.

Please Note that if customer declines Recurring Annual Support Options, then they will have to pay separately for the App or forfeight ability to use the G2 Mobile Alerting App. Any deviation from device license numbers listed above subjects proposal to change.

PRIMARY DISPATCH MAPPING SERVICE

Mapping System costs typically only need to be assumed once per dispatching agency, no matter how many stations are dispatched (unless redundant centers or further modifications are needed). Costs for this part of the system are often shared between consolidated agencies.

USDD-HOSTED MAPPING - INCLUDED (at no additional cost while under Warranty/Support)

Item	Unit	Mfr	Qty	Description	Part No.	US List Unit	QUOTE UNIT	QUOTE EXT	
M1	YR	USDD	0	**G2 FSA Mapping Server - Yearly Hosting Cost** (Cloud/USDD Hosted) Using National Street Data we provide, as-is	**MAP-CLD**	$ 1,540.00	**$ 1,386.00**	0 included at no charge/no additional cost	

CUSTOMER-HOSTED MAPPING

Item	Unit	Mfr	Qty	Description	Part No.	US List Unit	QUOTE UNIT	QUOTE EXT	
M2	EA	USDD	0	**G2 FSA Mapping Server** (Hardware for mapping interface) 1@2RU ONLY NEED TO INCLUDE IF YOU DO NOT WISH USDD TO HOST. Would contain only your data / Accessible only to your system.	**MAP-CUS**	$ 4,625.00	**$ 4,162.50**	**$ -**	

MAPPING GATEWAY SERVICES

Item	Unit	Mfr	Qty	Description	Part No.	US List Unit	QUOTE UNIT	QUOTE EXT	
M3	HR	USDD	0	**System Configuration and Modification** for Mapping	**MAP-CM**	$ 280.00	**$ 252.00**	**$ -**	
M4	LOT	USDD	0	**Customer-Hosted Mapping Server Installation and Start-up**	**MAP-ISU**	$ 5,825.00	**$ 5,242.50**	**$ -**	
M5	HR	USDD	0	Import Customer Vector Data	**MAP-IVD**	$ 280.00	**$ 252.00**	**$ -**	
M6	HR	USDD	0	Import Customer Raster Data	**MAP-IRD**	$ 280.00	**$ 252.00**	**$ -**	
M7	LOT	USDD	0	**Mapping Gateway Project Management**	**MAP-PM**	$ 415.00	**$ 373.50**	**$ -**	
M8	LOT	USDD	0	**Training - Mapping Service - On-Site** (4 Hours / Train-The-Trainer)	**MAP-TRN-O**	$ 2,400.00	**$ 2,160.00**	**$ -**	
M9	LOT	USDD	0	**Training - Mapping Services - Remote Refresh** (4 Hours / Train-The-Trainer)	**MAP-TRN-R**	$ 1,200.00	**$ 1,080.00**	**$ -**	
M10	LOT	USDD	0	**Training - Mapping Services - At Arizona Training Center**	**MAP-TRN-AZ**	$ 1,600.00	**$ 1,440.00**	**$ -**	
M11	LOT	USDD	0	Misc Option 1		$ -	**$ -**	**$ -**	

PRIMARY DISPATCH MAPPING SERVICE	**System Total:**	**$ -**
	Shipping Total:	**$ -**
	System Subtotal	**$ -**

PRIMARY DISPATCH WARRANTY & SUPPORT

INCLUDES G2 MOBILE SMART-PHONE ALERTING APPS & USDD-HOSTED MAPPING SERVICES (if available).
Customer must elect to choose any coverage they require beyond initial warranty period, or USDD will not be authorized to provide any service or support. Mobile Smart Phone Alerting App and Mapping Services only avaible to customer while under warranty or elected recurring annual support. Support Agreements subject to change if system design is modified. For additional details, please review current USDD Warranty Statement and Service Agreement

DISPATCH-LEVEL WARRANTY & OPTIONAL RECURRING ANNUAL SUPPORT									
Item	**Unit**	**Mfr**	**Qty**	**Description**	**Part No.**	US List Unit	**QUOTE UNIT**	**QUOTE EXT**	
17	HR	USDD	**1.5**	[STANDARD] **1st YEAR WARRANTY & SUPPORT** FOR THIS DISPATCH SYSTEM (or Component): Telephone / Remote Access Support (8:00 AM - 5:00 PM MST) PLEASE NOTE: An additional 6 months (for total of 18 months/1.5 years) of initial warranty has been offered by USDD for no additional cost so all stations can be installed and enjoy same warranty/support start/stop dates)	**RS-1YR-STD**	$ 2,088.00	**$1,879.20**	**2818.8 but No Charge For Initial Warranty Period / Not Included in Subtotals**	
18	LOT	USDD	**0.0**	[STANDARD] EACH **ADDITIONAL YEAR** (12-Months) **WARRANTY & SUPPORT** FOR THIS DISPATCH SYSTEM (or Component): Telephone / Remote Access Support (8:00 AM - 5:00 PM MST) IF QUANTITY '0' THEN NO ADDITIONAL SUPPORT IS ASSUMED OR AUTHORIZED BEYOND INITIAL WARRANTY PERIOD	**RS-AYR-STD**	$ 2,088.00	**$ 1,879.20**	**$ -**	

INDIVIDUAL DISPATCH SYSTEMS TOTALS

PRIMARY DISPATCH G2 FSA SYSTEM TOTAL:	**$ 44,174.34**
PRIMARY DISPATCH MOBILE APP SERVICE TOTAL:	**$ -**
PRIMARY DISPATCH MAPPING SERVICE TOTAL:	**$ -**

ENTIRE DISPATCH-LEVEL SUBTOTALS (NOW INCLUDING WARRANTY & OPTIONAL SUPPORT AS WELL)

ALL DISPATCH-LEVEL SYSTEMS SUBTOTAL:	**$ 44,048.34**
ALL DISPATCH-LEVEL SHIPPING SUBTOTAL:	**$ 126.00**
ALL DISPATCH-LEVEL WARRANTY & SUPPORT:	**$ -**
PRIMARY DISPATCH-LEVEL GRAND TOTAL:	**$ 44,174.34**

(SEE 'SECTION TOTALS' PAGE FOR EVEN MORE DETAIL)

US DIGITAL DESIGNS

1835 E. Sixth St. Suite #27
Tempe, Arizona 85281
877-551-8733 tel *480-290-7892 fax*

QUOTE

DATE: **4/20/17**
Expires: **7/19/17**

Quote SUBMITTED TO:
City of Lovington, New Mexico
for Lovington Fire Department

REF PROPOSAL
NM_LOVI001 v1 **DISPATCH-LEVEL**

BACKUP DISPATCH G2 FSA SYSTEM

Dispatch center costs typically only need to be assumed once per dispatching agency, no matter how many stations are dispatched (unless redundant centers or further modifications are needed). Costs for this part of the system are often shared between consolidated agencies.

COMMUNICATIONS GATEWAY EQUIPMENT

Item	Unit	Mfr	Qty	Description	Part No.	US List Unit	QUOTE UNIT	QUOTE EXT	
D1a	PR	USDD	1	**G2 Communications Gateway Pair** (Hardware for CAD interface) 2@2RU each	**G2-GW**	$ 9,250.00	**$ 8,325.00**	**$ 8,325.00**	
D2	Kit	USDD	1	**Multi-Port Ethernet Interface Pair** (8 Ports Total) to support additional networks	**MPE-8**	$ 1,175.00	**$ 1,057.50**	**$ 1,057.50**	
D3a	Kit	USDD	1	**G2 Gateway Audio Radio Interface** (**GaRi**) - Rack Mount	**GaRi-RM**	$ 1,885.00	**$ 1,696.50**	**$ 1,696.50**	
D3b	Kit	USDD	0	**G2 Gateway Audio Radio Interface** (**GaRi**) - Flange Mount	**GaRi-FM**	$ 1,885.00	**$ 1,696.50**	**$ -**	
D4	Kit	USDD	0	**G2 Gateway Audio Serial Interface** (**GaSi**)	**GaSi**	$ 1,440.00	**$ 1,296.00**	**$ -**	
D5	Kit	USDD	0	**G2 HDTV REMOTE** Module (TV & Electrical Outlet by Others)	**TVR**	$ 875.00	**$ 787.50**	**$ -**	
D6	Kit	USDD	0	**G2 Light Tower Interface**	**LTI**	$ 520.00	**$ 468.00**	**$ -**	

COMMUNICATIONS GATEWAY INTERFACES

Item	Unit	Mfr	Qty	Description	Part No.	US List Unit	QUOTE UNIT	QUOTE EXT	
D7	LOT	USDD	0	**Radio System Interface**	**RSI**	$13,650.00	**$12,285.00**	**$ -**	
D8	LOT	USDD	0	**Additional Radio Channel**	**ARC**	$ 4,225.00	**$ 3,802.50**	**$ -**	
D9	LOT	CAD	1	**BACKUP CAD Interface** - **Cappers** (USDD-side Only - Customer responsibility to discuss CAD-side costs (if any) with their vendor)	**PCAD-I**	$ 5,445.00	**$ 4,900.50**	**$ 4,900.50**	

COMMUNICATIONS GATEWAY SERVICES

Item	Unit	Mfr	Qty	Description	Part No.	US List Unit	QUOTE UNIT	QUOTE EXT	
D10	HR	USDD	25	**BACKUP Gateway Configuration & Modifications**	**GW-CM**	$ 280.00	**$ 252.00**	**$ 6,300.00**	
D11	LOT	USDD	0	**Radio System Interface Modification**	**RSI-CM**	$ 4,225.00	**$ 3,802.50**	**$ -**	

D12	LOT	USDD	**1**	**Gateway Installation and Start-up**	**GW-ISU**	$ 5,825.00	**$ 5,242.50**	**$ 5,242.50**	
D13	LOT	USDD	**1**	**Gateway Project Management**	**GW-PM**	$ 319.59	**$ 287.63**	**$ 287.63**	
D14a	LOT	USDD	**0**	**Training - System Administrator - On-Site** (4 Hours / Train-The-Trainer)	**TRA-SA-O**	$ 2,750.00	**$ 2,475.00**	**$ -**	
D14b	LOT	USDD	**0**	**Training - System Administrator - Remote Refresh** (4 Hours / Train-The-Trainer)	**TRA-SA-R**	$ 1,200.00	**$ 1,080.00**	**$ -**	
D15a	LOT	USDD	**0**	**Training - Dispatch Operator - On-Site** (4 Hours / Train-The-Trainer)	**TRA-DO-O**	$ 2,750.00	**$ 2,475.00**	**$ -**	
D15b	LOT	USDD	**0**	**Training - Dispatch Operator - Remote Refresh** (4 Hours / Train-The-Trainer)	**TRA-DO-R**	$ 1,200.00	**$ 1,080.00**	**$ -**	
D16a	LOT	USDD	**0**	**Training - Installation Contractor - On-Site** / USDD G2 Certification / (8 Hours / Train-The-Trainer (TBD - only needed if required to use non-certified contractor)	**TRA-IC-O**	$ 4,325.00	**$ 3,892.50**	**$ -**	
D16b	LOT	USDD	**0**	**Training - Installation Contractor - At Arizona Training Center** / USDD G2 Certification / 4 Hours / Train-The-Trainer (TBD - only needed if required to use non-certified contractor)	**TRA-IC-AZ**	$ 1,600.00	**$ 1,440.00**	**$ -**	
D17a	HR	USDD	**0**	Management Meeting with Customer / at USDD Tempe, AZ location (per Hour / Per Person)	**MTG-MGT-U**	$ 244.00	**$ 219.60**	**$ -**	
D17b	LOT	USDD	**0**	Management Meeting with Customer / at Customer Site (above per hour/per person cost + required travel and accomodation)	**MTG-MGT-C**	$ -	**$ -**	**$ -**	
D18	LOT	USDD	**0**	Misc Option 1		$ -	**$ -**	**$ -**	
D19	LOT	USDD	**0**	Misc Option 2		$ -	**$ -**	**$ -**	

BACKUP DISPATCH G2 FSA SYSTEM		
	System Total:	**$ 27,809.63**
	Shipping Total:	**$ 126.00**
	System Subtotal	**$ 27,935.63**

BACKUP DISPATCH MAPPING SERVICE

Mapping System costs typically only need to be assumed once per dispatching agency, no matter how many stations are dispatched (unless redundant centers or further modifications are needed). Costs for this part of the system are often shared between consolidated agencies.

USDD-HOSTED MAPPING - INCLUDED (at no additional cost while under Warranty/Support)

Item	Unit	Mfr	Qty	Description	Part No.	US List Unit	QUOTE UNIT	QUOTE EXT	
M1	YR	USDD	0	**G2 FSA Mapping Server - Yearly Hosting Cost** (Cloud/USDD Hosted) Using National Street Data we provide, as-is	**MAP-CLD**	$ 1,540.00	**$ 1,386.00**	0 included at no charge/no additional cost	

CUSTOMER-HOSTED MAPPING

Item	Unit	Mfr	Qty	Description	Part No.	US List Unit	QUOTE UNIT	QUOTE EXT	
M2	EA	USDD	0	**BACKUP G2 FSA Mapping Server** (Hardware for mapping interface) 1@2RU ONLY NEED TO INCLUDE IF YOU DO NOT WISH USDD TO HOST. Would contain only your data / Accessible only to your system.	**MAP-CUS**	$ 4,625.00	**$ 4,162.50**	**$ -**	

MAPPING GATEWAY SERVICES

Item	Unit	Mfr	Qty	Description	Part No.	US List Unit	QUOTE UNIT	QUOTE EXT	
M3	HR	USDD	0	**BACKUP System Configuration and Modification** for Mapping	**MAP-CM**	$ 280.00	**$ 252.00**	**$ -**	
M4	LOT	USDD	0	**BACKUP Customer-Hosted Mapping Server Installation and Start-up**	**MAP-ISU**	$ 5,825.00	**$ 5,242.50**	**$ -**	
M5	HR	USDD	0	Import Customer Vector Data	**MAP-IVD**	$ 280.00	**$ 252.00**	**$ -**	
M6	HR	USDD	0	Import Customer Raster Data	**MAP-IRD**	$ 280.00	**$ 252.00**	**$ -**	
M7	LOT	USDD	0	**Mapping Gateway Project Management**	**MAP-PM**	$ 415.00	**$ 373.50**	**$ -**	
M8	LOT	USDD	0	**Training - Mapping Service - On-Site** (4 Hours / Train-The-Trainer)	**MAP-TRN-O**	$ 2,400.00	**$ 2,160.00**	**$ -**	
M9	LOT	USDD	0	**Training - Mapping Services - Remote Refresh** (4 Hours / Train-The-Trainer)	**MAP-TRN-R**	$ 1,200.00	**$ 1,080.00**	**$ -**	
M10	LOT	USDD	0	**Training - Mapping Services - At Arizona Training Center**	**MAP-TRN-AZ**	$ 1,600.00	**$ 1,440.00**	**$ -**	
M11	LOT	USDD	0	Misc Option 1		$ -	**$ -**	**$ -**	

BACKUP DISPATCH MAPPING SERVICE	**System Total:**	**$ -**
	Shipping Total:	**$ -**
	System Subtotal	**$ -**

BACKUP DISPATCH WARRANTY & SUPPORT

Customer must elect to choose any coverage they require beyond initial warranty period, or USDD will not be authorized to provide any service or support. Support Agreements subject to change if system design is modified. For additional details, please review current USDD Warranty Statement and Service Agreement

DISPATCH-LEVEL WARRANTY & OPTIONAL RECURRING ANNUAL SUPPORT									
Item	Unit	Mfr	Qty	Description	Part No.	US List Unit	QUOTE UNIT	QUOTE EXT	
17	HR	USDD	**1.5**	[STANDARD] **1st YEAR WARRANTY & SUPPORT** FOR THIS DISPATCH SYSTEM (or Component): Telephone / Remote Access Support (8:00 AM - 5:00 PM MST) PLEASE NOTE: An additional 6 months (for total of 18 months/1.5 years) of initial warranty has been offered by USDD for no additional cost so all stations can be installed and enjoy same warranty/support start/stop dates)	**RS-1YR-STD**	$ 1,597.95	**$1,438.16**	**2157.2325 but No Charge For Initial Warranty Period / Not Included in Subtotals**	
18	LOT	USDD	**0.0**	[STANDARD] EACH **ADDITIONAL YEAR** (12-Months) **WARRANTY & SUPPORT** FOR THIS DISPATCH SYSTEM (or Component): Telephone / Remote Access Support (8:00 AM - 5:00 PM MST) IF QUANTITY '0' THEN NO ADDITIONAL SUPPORT IS ASSUMED OR AUTHORIZED BEYOND INITIAL WARRANTY PERIOD	**RS-AYR-STD**	$ 1,597.95	**$ 1,438.16**	**$ -**	

INDIVIDUAL DISPATCH SYSTEMS TOTALS

BACKUP DISPATCH G2 FSA SYSTEM TOTAL:	**$ 27,935.63**
BACKUP DISPATCH MAPPING SERVICE TOTAL:	**$ -**

ENTIRE DISPATCH-LEVEL SUBTOTALS (NOW INCLUDING WARRANTY & OPTIONAL SUPPORT AS WELL)

ALL DISPATCH-LEVEL SYSTEMS SUBTOTAL:	**$ 27,809.63**
ALL DISPATCH-LEVEL SHIPPING SUBTOTAL:	**$ 126.00**
ALL DISPATCH-LEVEL WARRANTY & SUPPORT:	**$ -**
PRIMARY DISPATCH-LEVEL GRAND TOTAL:	**$ 27,935.63**

(SEE 'SECTION TOTALS' PAGE FOR EVEN MORE DETAIL)

US DIGITAL DESIGNS

1835 E. Sixth St. Suite #27
Tempe, Arizona 85281
877-551-8733 tel *480-290-7892 fax*

QUOTE

DATE: **4/20/17**
Expires: **7/19/17**

Quote SUBMITTED TO:
City of Lovington, New Mexico
for Lovington Fire Department

REF PROPOSAL
NM_LOVI001 v1 **STATION-LEVEL**

STATION 02

Based from USDD G2 Fire Station Alerting System Design Drawing # USDD.NM_LOVI.FS02.FSA.2017.02.15.pdf

STATION LICENSES

Item	Unit	Mfr	Qty	Description	Part No.	US List Unit	QUOTE UNIT	QUOTE EXT	
L1	Ea	USDD	**1**	**G2 VOICEALERT** - Single Station License. One-Time/Perpetual (unless furthur USDD modification is needed)	**VA**	$ 927.00	**$ 834.30**	**$ 834.30**	
L2	Ea/Yr	USDD	**24**	**G2 MOBILE FSAS APP** - Single Device License. Up to 24 Licenses-Per-ATX are **offered at $0.00 cost each** as long as system is currently under warranty or elected recurring annual support coverage. See 'Mobile' Section for more detail.	**G2-APP-DLI**	$ 108.00	**$ 97.20**	**N/A - Included**	

STATION CONTROLLER

Item	Unit	Mfr	Qty	Description	Part No.	US List Unit	QUOTE UNIT	QUOTE EXT	
S1	Kit	USDD	**1**	**G2 ATX STATION CONTROLLER -** Power/Signal/Control up to 8 peripheral Remote Options. 4 Unique Amps/Zones available.	**ATX**	$ 20,000.00	**$ 18,000.00**	**$ 18,000.00**	
S2	Kit	USDD	**0**	**G2 EXPANSION KIT** - Allows ability to Power/Signal/Control up to 12 more peripheral Remote options per EXP.	**EXP**	$ 6,660.00	**$ 5,994.00**	**$ -**	
S3	Kit	USDD	**0**	Rack Mount Ears for ATX or EXP	ATX-E	$ 54.00	**$ 48.60**	**$ -**	
S4	Kit	USDD	**0**	Base Plate for ATX or EXP	ATX-P	$ 54.00	**$ 48.60**	**$ -**	

STATION PERIPHERAL COMPONENT OPTIONS

Item	Unit	Mfr	Qty	Description	Part No.	US List Unit	QUOTE UNIT	QUOTE EXT	
S5a	Ea	USDD	**0**	**G2 ROOM REMOTE 1** Module (Legacy/End of Life)	**RR1**	$ 1,830.00	**$ 1,647.00**	**$ -**	
S5b	Ea	USDD	**0**	RR Trim Plate, for Flush-Mount	RR1-TP	$ 46.00	**$ 41.40**	**$ -**	
S5c	Ea	USDD	**0**	RR Back-Straps, for solid-wall flush-mounting	RR1-BS	$ 27.00	**$ 24.30**	**$ -**	
S6a	Ea	USDD	**0**	**G2 ROOM REMOTE 2** Module / 2017 version 2	**RR2**	$ 1,830.00	**$ 1,647.00**	**$ -**	
S6b	Ea	USDD	**0**	RR2 Adpater Plate, for Retrofit in RR1 Wall Cavity	RR2-AP	$ 46.00	**$ 41.40**	**$ -**	
S6c	Ea	USDD	**0**	RR2 Surface Mount Back Box, for SURFACE MOUNT (hard wall) installation. Three (3) 3/4" conduit knock-outs.	RR2-BB	$ 175.00	**$ 157.50**	**$ -**	
S7	Ea	USDD	**0**	**G2 MESSAGE REMOTE 1** Module (Legacy/End of Life)	**MR1**	$ 1,167.00	**$ 1,050.30**	**$ -**	
S8	Ea	USDD	**0**	**G2 MESSAGE REMOTE 2** Module (2017 Version 2)	**MR2**	$ 1,275.00	**$ 1,147.50**	**$ -**	
S9	Ea	USDD	**0**	**G2 SIGN REMOTE** Module	**SR**	$ 583.00	**$ 524.70**	**$ -**	
S10a	Ea	USDD	**2**	**G2 HDTV REMOTE** Module (TV & Electrical Outlet by Others; C.E.C. control subject to TV ability)	**TVR**	$ 875.00	**$ 787.50**	**$ 1,575.00**	
S10b	Ea	USDD	**0**	Flat Panel Monitor / Smart HDTV 40-43" (Electrical Outlet/Provision By Others; C.E.C. control subject to TV ability)	**FP-43**	$ 956.64	**$ 860.98**	**$ -**	
S10c	Ea	USDD	**0**	Flat Panel / TV Mount- Universal 23"-46" Tilt	**FPM-U**	$ 66.58	**$ 59.92**	**$ -**	

S11a	Ea	USDD	**9**	**G2 MESSAGE SIGN** (Digital LED) **STANDARD GammaSign** / 24" Active Screen Width	**MS-G-S**	$ 1,050.00	**$ 945.00**	**$ 8,505.00**	
S11b	Ea	USDD	**0**	**G2 MESSAGE SIGN** (Digital LED) **EXTENDED GammaSign** / 36" Active Screen Width	**MS-G-E**	$ 1,575.00	**$ 1,417.50**	**$ -**	
S11c	Ea	USDD	**0**	MS-G Adapter Plate, SINGLE. VESA 100, joins (1) MS-G-S (or-E) to any standard mount with VESA 100 hole patterns (mount not included)	**AP-S**	$ 38.00	**$ 34.20**	**$ -**	
S11d	Ea	USDD	**3**	MS-G Adapter Plate, DOUBLE, VESA 100, joins (2) MS-G -S(or-E) to any standard mount with VESA 100 hole patterns (mount not included)	**AP-D**	$ 49.00	**$ 44.10**	**$ 132.30**	
S11e	Ea	USDD	**0**	MS-G Hanger Kit. Hangs single or double (back-to-back) Message Signs (Gamma Version) from Ceiling. Includes both suspended ceiling T-Bar Scissor Clips and Hard-Pan Flange Mounts.	**MS-HK**	$ 73.00	**$ 65.70**	**$ -**	
S12	Ea	USDD	**3**	MS Mount - Articulating, Long reach	MS-MNT-ART-L	$ 287.00	**$ 258.30**	**$ 774.90**	
S13a	Ea	USDD	**0**	MESSAGE SIGN, Digital LED (BetaBrite - LEGACY Replacement 24" Screen Width)	MS-B	$ 360.00	**$ 324.00**	**$ -**	
S13b	Ea	USDD	**0**	MS Adapter Plate, VESA 100	MS-ADPT-V100	$ 60.00	**$ 54.00**	**$ -**	
S13c	Ea	USDD	**0**	MS Tie-Straps (pair) - join two MSs	MS-ADPT-STRP	$ 27.00	**$ 24.30**	**$ -**	
S14	Ea	USDD	**0**	**G2 I/O REMOTE** w/ 8 In & 8 Out	**IOR**	$ 1,165.00	**$ 1,048.50**	**$ -**	
S15	Ea	USDD	**1**	**G2 Strobe Light** / Red LED	**STR**	$ 500.00	**$ 450.00**	**$ 450.00**	
S16	Ea	USDD	**0**	**G2 Color Indicator Remote** - Up to 8 unique colors	**CIR**	$ 635.00	**$ 571.50**	**$ -**	
S17a	Ea	USDD	**2**	Push Button, Standard (Black)	PB-B	$ 100.00	**$ 90.00**	**$ 180.00**	
S17b	Ea	USDD	**2**	Push Button, Emergency (Red)	PB-R	$ 100.00	**$ 90.00**	**$ 180.00**	
S18a	Ea	Atlas	**1**	Audio Amplifier, External, Standard	AMP	$ 987.00	**$ 888.30**	**$ 888.30**	
S18b	Ea	Atlas	**1**	Shelf, Under Table or Wall Mount, for 1U 1/2 Rack	AMP-S	$ 66.00	**$ 59.40**	**$ 59.40**	
S19	Ea	Bogn	**7**	SPEAKER - APP BAY/OUTDOOR - Weatherized, Surface Mount, 70v	SPK-W-SM	$ 280.00	**$ 252.00**	**$ 1,764.00**	
S20a	Ea	Bogn	**11**	Speaker - Standard, Flush Mount, 70v (**S86**)	SPK-STD-FM	$ 73.00	**$ 65.70**	**$ 722.70**	
S20b	Ea	Bogn	**0**	Speaker - Standard, Surface Mount (**MB**), 70v	SPK-STD-SM	$ 73.00	**$ 65.70**	**$ -**	
S21a	Ea	USDD	**14**	**G2 SPEAKER - LED Illuminated** - Flush Mount, 70v	**SPK-LED-FM**	$ 297.00	**$ 267.30**	**$ 3,742.20**	
S21b	Ea	USDD	**0**	**G2 SPEAKER - LED Illuminated** - Surface Mount (**MB**), 70v	**SPK-LED-SM**	$ 297.00	**$ 267.30**	**$ -**	
S23	Ea	TIC	**0**	Transformer, 8ohm to 70V, External	XFMR	$ 53.00	**$ 47.70**	**$ -**	
S24a	Ea	TBD	**1**	ATX UPS, Standard	UPS-STD	$ 923.00	**$ 830.70**	**$ 830.70**	
S24b	Ea	TBD	**1**	Shelf/Bracket, Wall-Mount for UPS	UPS-WMB	$ 57.00	**$ 51.30**	**$ 51.30**	
S25	Ea	USDD	**0**	Miscellaneous	MISC	$ -	**$ -**	**$ -**	

STATION-LEVEL SERVICES

Item	Unit	Mfr	Qty	Description	Part No.	US List Unit	QUOTE UNIT	QUOTE EXT	
S26	Ea	USDD	**1**	**Station Installation** (Kirkmeyer Electric, Inc.)	**ST-INST**	$ 19,696.11	**$ 17,726.50**	**$ 17,726.50**	
S27	Ea	USDD	**0**	**Station Remediation** (Removal and Disposal of Legacy Equipment Not currently Assumed or Included, nor is any related Remediation to Paint, Drywall, etc.)	**ST-INST**	$ -	**$ -**	**$ -**	
S28	Ea	USDD	**1**	**Station Configuration & Start-Up**	**ST-SU**	$ 2,579.34	**$ 2,321.41**	**$ 2,321.41**	
S29	Ea	USDD	**1**	**Station Project Management**	**ST-PM**	$ 816.79	**$ 735.11**	**$ 735.11**	
S30	Ea	USDD	**1**	**Station Engineering / Design Services**	**ST-ES**	$ 429.89	**$ 386.90**	**$ 386.90**	
S31	Ea	USDD	**1**	**Station Documentation**	**ST-DM**	$ 64.48	**$ 58.04**	**$ 58.04**	
S32a	Ea	USDD	**0**	**Station Training - User/Technician. On-Site @ Station.** 1 Hour, 1 Visit. (3 Units/Hours suggested to cover 3 shifts)	**TRA-UT-O**	$ 2,400.00	**$ 2,160.00**	**$ -**	

S32b	Ea	USDD	**0**	**Station Training - User/Technician** / Remote Refresh (2 Hours / Train-The-Trainer)	**TRA-UT-R**	$ 600.00	**$ 540.00**	**$ -**	
S33a	Ea	USDD	**0**	**Training - Installation Contractor - On-Site** / USDD G2 Certification / 8 Hours / Train-The-Trainer (TBD - only needed if requied to use non-certified contractor)	**TRA-IC-O**	$ 4,325.00	**$ 3,892.50**	**$ -**	
S33b	Ea	USDD	**0**	**Training - Installation Contractor - At Arizona Training Center** / USDD G2 Certification / 8 Hours / Train-The-Trainer (TBD - only needed if required to use non-certified contractor)	**TRA-IC-AZ**	$ 1,600.00	**$ 1,440.00**	**$ -**	
S34	Ea	USDD	**0**	**Miscellaneous/TBD**	**MISC**	$ -	**$ -**	**$ -**	

STATION-LEVEL WARRANTY & OPTIONAL RECURRING ANNUAL SUPPORT

Item	Unit	Mfr	Qty	Description	Part No.	US List Unit	QUOTE UNIT	QUOTE EXT	
S35a	HR	USDD	**1.5**	[**STANDARD**] **1st YEAR WARRANTY & SUPPORT** FOR THIS STATION SYSTEM (or component): Telephone / Remote Access Support (8:00 AM - 5:00 PM MST) PLEASE NOTE: An additional 6 months (for total of 18 months/1.5 years) of initial warranty has been offered by USDD for no additional cost so all stations can be installed and enjoy same warranty/support start/stop dates)	**RS-1YR-STD**	$ 3,869.01	**$ 3,482.11**	5223.1635 but No Charge For Initial Warranty Period / Not Included in Subtotals	
S36b	LOT	USDD	**0.0**	[**STANDARD**] EACH **ADDITIONAL YEAR** (12-Months) **WARRANTY & SUPPORT** FOR THIS STATION SYSTEM (or Component): Telephone / Remote Access Support (8:00 AM - 5:00 PM MST) IF QUANTITY '0' THEN NO ADDITIONAL SUPPORT IS ASSUMED OR AUTHORIZED BEYOND INITIAL WARRANTY PERIOD	**RS-AYR-STD**	$ 3,869.01	**$ 3,482.11**	**$ -**	

STATION 02		
	System:	**$ 59,918.05**
	Shipping:	**$ 1,320.00**
	Warranty & Support:	**$ -**
	STATION SUBTOTAL:	**$ 61,238.05**

Warranty & Support Notes:
Customer must elect to choose any coverage they require beyond initial warranty period, or USDD will not be authorized to provide any service or support. Mobile Smart Phone Alerting App and Mapping Services only avaible to customer while under warranty or elected recurring annual support. Support Agreements subject to change if system design is modified. For additional details, please review current USDD Warranty Statement and Service Agreement

Station System Installation Notes:
01 - Unless specifically detailed in this proposal, no installation by USDD or it's subcontractors is assumed or provided.
02 - Because these are mission-critical systems, USDD can only warrant and support systems installed by G2 Trained and Certified Contractors.
03 - USDD can source, qualify, train and certify Local Licensed Regional Subcontrators where needed.
04 - Installation warranted by installation contractor - G2 FSAS warranted, serviced and supported by USDD.
05 - Unless specifically detailed in this proposal, installation to be performed during normal working hours.
06 - Unless specifically detailed in this proposal, no permit fees or material charges have been included.
07 - Unless specifically detailed in this proposal, no removal or remediation has been assumed or included.
08 - Unless specifically detailed in this proposal, no bonds of any type (performance, bid) have been assumed,included or budgeted for in this proposal.
09 - USDD FSAS Equipment to be made available by owner to Installation Contractor prior to on-site arrival.
10 - Structural backing for system devices and other millwork (not specifically detailed) by others.
11 - If applicable, Gas Control Shutoff Valve Addendum (to USDD and installation contractor) must be signed prior to installation.
12 - All electrical power, including (but not limited to) raceway,conduit, backboxes, service panels, high-voltage wiring and fixtures by others.
13 - All communications pathway infrastructure (network, radio, etc.) by others unless specifically detailed in this proposal.
14 - USDD cannot warrant nor support any owner-furbished (3rd-Party) system or component we are required to integrate with. USDD cannot warrant nor support any system or component it has not proofed engineering for and has not specifically authorized for use within public safety environments.
15 - Any misuse, unauthorized modification, improper installation, excessive shock, attempted repair, accident, or improper or negligent use, storage, transportation, or handling by any party other than USDD shall render this limited warranty null, void and of no further effect

US DIGITAL DESIGNS

1835 E. Sixth St. Suite #27
Tempe, Arizona 85281
877-551-8733 tel *480-290-7892 fax*

QUOTE

DATE: 4/20/17
Expires: 7/19/17

Quote SUBMITTED TO:
City of Lovington, New Mexico
for Lovington Fire Department

REF PROPOSAL
NM_LOVI001 v1

Section Totals

SECTION TOTALS

[UNLESS OTHERWISE NOTED, ALL PRICES ARE $US]

DISPATCH-LEVEL SUBTOTAL		**$**	**72,109.97**
Includes:	PRIMARY DISPATCH G2 FSA SYSTEM :	$	44,174.34
	PRIMARY DISPATCH MOBILE APP SERVICE :	$	-
	PRIMARY DISPATCH MAPPING SERVICE :	$	-
	PRIMARY DISPATCH WARRANTY & SUPPORT :	$	-
Includes:	BACKUP DISPATCH G2 FSA SYSTEM :	$	27,935.63
	BACKUP DISPATCH MAPPING SERVICE :	$	-
	BACKUP DISPATCH WARRANTY & SUPPORT :	$	-
Notes:			
STATION-LEVEL SUBTOTAL		**$**	**61,238.05**
Includes:	STATION 02 SYSTEM:	$	61,238.05
	STATION 02 WARRANTY & SUPPORT:	$	-
Notes:			
US Digital Designs System Total		**$**	**133,348.03**

(TBD By Customer) Customer must elect to choose any coverage they require beyond initial warranty period, or USDD will not be authorized to provide any service or support. Mobile Smart Phone Alerting App and Mapping Services only avaible to customer while under warranty or elected recurring annual support. Support Agreements subject to change if system design is modified. For additional details, please review current USDD Warranty Statement and Service Agreement

STANDARD TERMS AND CONDITIONS OF SALE

(Contract Sales)

(PER ATTACHED/RELATED PURCHASE AGREEMENT, EUAA & SUPPORT AGREEMENT)

SECTION 283100 - FIRE DETECTION AND ALARM SYSTEM

PART 1- GENERAL

1.1 RELATED DOCUMENTS

A. Related Documents: Drawings, Notice to Bidders, General Conditions, Project Coordination, RFP Format, Requested RFP Alternatives, Cutting and Patching, Standard Terms and Conditions, and all Appendices apply to the work of this section.

1.2 SUMMARY

A. This Section includes fire alarm systems, including but not limited to manual stations, detectors, signal equipment, controls, and devices. Note that this is a performance based specification. Equipment/device quantities and locations indicated are diagrammatic. Design of the fire alarm system, including device placements, selection and quantities, shall be by a NICET level III designer in accordance with the requirements of the New Mexico State Fire Marshall's Office (NMSFMO). The design shall be approved by the NMSFMO. Refer to additional submission requirements below.

1.3 SCOPE

A. This specification document provides the requirements for the installation, programming and configuration of a complete digital protocol analog addressable fire alarm system. This system shall include, but not be limited to, system cabinet, power supply, built in Signaling Line Circuit (SLC), 80 character LCD annunciator, built in dual line Digital Communicator associated peripheral devices, batteries, wiring, conduit and other relevant components and accessories required to furnish a complete and operational Life Safety System.

1.4 DESCRIPTION OF WORK

A. Provide all required labor, warranty labor, materials, equipment, system programming, submittals and services necessary for new devices, replacement devices, equipment upgrades and required circuits to provide complete and operational fire alarm systems and the fire alarm networking annunciation as hereinafter described and as shown on the drawings.

B. Work shall begin at the source of 120 volt AC power for the fire alarm panel and shall include but not be limited to providing the following:

1. Intelligent/Addressable Fire Alarm Control Panels
2. SLC Circuits
3. Dedicated Power Circuits
4. Initiation Circuits
5. Notification Circuits

6. Control Circuits
7. Monitoring Circuits
8. Conduit Sleeves as shown on the Drawings
9. Detection Devices
10. Monitoring of Automatic Sprinkler Tamper and Flow Switches
11. Manual Pull Stations
12. Audible/Visual Devices
13. Alarm Verification
14. HVAC Shutdown
15. Door Release/Unlock
16. Connection to Building Automation System
17. Monitoring of Releasing Panels
18. Digital Alarm Communicator Transmitter (DACT)
19. DACT Circuits to Telephone Equipment
20. Alpha-Numeric Annunciator

C. Provide a minimum of six hours training for staff personnel, in the operation and use of the system.

1.5 REFERENCES

A. All work shall be installed in accordance with all applicable codes and referenced design standards:

1. International Building Code (IBC), with New Mexico State Building Code amendments.
2. International Existing Building Code, with New Mexico State Building Code amendments.
3. International Fire Code, with New Mexico State Building Code amendments
4. NFPA 72 - , National Fire Alarm Code
5. NFPA 70 - , National Electrical Code
6. American National Standards ICC/ANSI A117.1
7. Factory Mutual Industrial Risk Insurers Recommended Practices

1.6 SYSTEM DESCRIPTION

A. The system shall operate as a low voltage fire alarm system and shall be a complete intelligent addressable supervised fire alarm system as hereinafter specified. Initiation circuits shall meet the minimum requirements of Class B, Style B. Supervisory circuits shall meet the minimum requirements of Class B, Style B. Notification circuits shall meet the minimum requirements of Class B, Style Y. Signaling line circuits shall meet the minimum requirements of Class B, Style 4. Auxiliary circuits, where not installed as signaling line circuits, shall meet the minimum requirements of a Class B, Style W notification circuit. Circuits for relay coil operation shall be 24 volt maximum.

B. The control panel shall receive its power from a 120 volt AC dedicated branch circuit and labeled “Fire Alarm”. The 24 volt DC power for all system initiation, supervisory, notification

and control circuits shall be provided by the main fire alarm control panel power supplies or listed auxiliary power supplies.

C. Upon loss of power to the control panel, the entire system shall transfer to secondary power within 10 seconds, and without loss of signals. The system shall operate under secondary power in normal or trouble conditions for twenty-four (24) hours and have sufficient power to support complete alarm condition operation for a subsequent five (5) minutes.

D. Upon loss of primary power to the control panel(s), all emergency exits that are locked by electronic means and that can prevent egress by manual means, shall be unlocked.

E. System network topography shall be master-subordinate. The Local Area Network circuit medium between the network nodes shall be copper conductor Style 4. All network nodes shall have the capability for local operation of alarm detection, supervisory, occupant notification and control functions if network operation is impaired or disconnected. Systems using token ring or polling protocols shall be acceptable.

F. System Operation shall be:

1. Abnormal circuit conditions as required for the Class and Style of the circuit, shall initiate a "trouble" condition at the control panels and remote annunciators for that specific circuit. The “trouble” indication shall describe the nature of the condition on the affected circuit. The DACT shall transmit a general "trouble" condition to an Underwriters Laboratories, Inc. (UL) listed central station. A central station as approved by responding fire department or fire marshal.
2. Devices in an abnormal state shall initiate a "trouble" condition at the control panels and remote annunciators for that specific device. The "trouble" indication shall describe the nature of the condition and specific address and alpha-numeric description of the device affected. The DACT shall transmit a general "trouble" condition to a UL listed central station. A central station as approved by responding fire department or fire marshal.
3. The closed position of a sprinkler system control valve shall indicate a valve specific "supervisory" condition at the control panels and remote annunciators. The DACT shall transmit a general "supervisory" condition to a UL listed central station.
4. Activation of any pull station, return-side duct detector, heat detector, smoke detector, device monitoring water-flow in the sprinkler system, or device monitoring activation of any suppression system shall initiate a device specific "alarm" condition at the control panels and remote annunciators by device address and by device location label. The DACT shall transmit a general alarm to a UL listed central station.
5. Activation of any supply-side duct detector shall indicate a device specific supervisory" condition at the control panels and remote annunciators. The ACT shall transmit a general "supervisory" condition to a UL listed central station.
6. Activation of any supply-side or return-side duct smoke detector shall shut down the affected air handling unit.
7. Activation of any water-flow monitoring device shall activate the audible device at the fire department connection on the exterior of the building.
8. Activation of any smoke detector adjacent to a fire door maintained open by electric holders shall release the door to close.
9. Activation of an alarm condition in a temporary or portable classroom shall indicate the building of alarm on the main panel and remote annunciators. Main building notification appliances shall not energize. The DACT shall transmit a general "alarm" condition to a UL listed central station.

10. Additional indications, notifications, enabling functions or control functions shall be as outlined in the Fire Alarm Control-by-Event Matrix on the drawings.

G. Initiation of an "alarm" condition shall result in the following functions to be performed by the system:

1. Initiate an alarm indication on the panel by tone and illuminate the corresponding device specific alphanumeric LCD description. Manually activating the "Alarm Silence" shall silence the tone at the panel. The alarm alphanumeric display shall remain "on" at the panel until the condition causing the alarm has been cleared and reset. An additional alarm reported to the panel subsequent to activating the "Alarm Silence" shall reactivate the panel tone.
2. Actuate all audible/visual and visual devices throughout the building.
3. Manually activating the "Alarm Silence" at the panel shall de-energize the (audible/visual, speaker/visual, visual, and speaker) devices. An additional alarm reported to the panel subsequent to activating the "Alarm Silence" shall eenergize the udible/visual, visual, and speaker devices.
4. Transmit an “alarm” signal to the UL listed central station.

H. All wiring 7 feet or less above the finished floor and not concealed in partitions, or subject to physical damage, or non-power limited, or where required by applicable codes shall be installed in conduit.

1.7 QUALITY ASSURANCE

A. All work shall meet the requirements of the applicable codes, New Mexico State Fire Marshal’s Office (Fire Marshal).

B. All equipment and components shall be listed by Underwriters' Laboratories for the actual intended use unless hereinafter specifically excluded from such a listing.

C. Installation and supervision of installation shall be in strict compliance with the requirements of the regulations, licenses, and permits for fire alarm system installers in this jurisdiction and must possess a Certificate of Fitness from the Fire Marshal.

D. Installer must have been actively engaged in the business of selling, installing, and servicing fire alarm systems for at least three (3) years.

E. Installer must be an authorized representative of the Fire Alarm Equipment Manufacturer (FAEM) and have technical factory training specifically for the system proposed.

F. The FAEM shall have a representative supervise the final connection of devices and wiring and programming of the control panels.

1.8 REGULATORY REQUIREMENTS

A. All work shall meet the requirements of Section 1.3.

B. No approvals or interpretations of the design documents shall be pursued except through the Engineer of Record by written submission.

C. Any work performed prior to the satisfactory review of the shop drawings by the Engineer of Record and determined to be non-compliant with the contract documents or applicable codes by the Authority's Representative or Engineer of Record will be replaced at the Contractor's expense.

D. Contractor shall submit all records of final testing to the Fire Marshal and Authority. The system will not be acceptable until final testing is complete and until receipt and approval of the Inspection and Testing Form is received from the Fire Marshal.

E. The Contractor hereby acknowledges that all dollar amounts quoted in contract documents, correspondence, unit prices, alternate proposals and any other prices provided by the Contractor or requested by the Owner's representatives include all sales, use, value-added, excise or other taxes currently in place or enacted in the course of the project. No additional amounts of compensation are to be charged to the Owner for taxes applicable to this project.

1.9 SUBMITTALS

A. Prior to commencement of work the contractor shall submit to the Authority the following:

1. One (1) copy of the transmittal of the permit application to the Applicable local agency.
2. One (1) copy of the authorization that the installing contractor is a duly qualified representative of the fire alarm equipment manufacturer.
3. One (1) copy of the installing contractor's Certificate of Fitness from the Fire Marshal.

B. Prior to application for the initial payment, the following documents shall be received and approved by the Authority:

1. Two sets of reproducible installation drawings and three sets of bond installation drawings. Submittal must be comprehensive of the entire project, complete in all detail, and include, but not be limited to, the following:

    a. All information and sheets required by the Fire Marshal's published "Fire Detection and Alarm System Submittal Guidelines".
    b. Floor plans showing equipment placement, including existing equipment placement. For equipment circuits to be installed in this project, floor plans shall show wiring types and sizes, conduit types and sizes, wiring and raceway routes. Floor plans shall be provided in AUTOCAD Release 2013 or later version and also in PDF format.
    c. Sequence of Operations to include a detailed description of the operation of each system function.

d. Point to point wiring diagrams for equipment to be installed in this contract.
e. Single riser diagram for notification devices and circuits, auxiliary power supplies, audio devices and circuits, and existing devices and circuits.
f. Supervisory and alarm current calculations for primary power and emergency battery sizing.
g. Voltage drop and signal loss calculations for notification and communications circuits.
h. Manufacturers' literature on all system equipment and system conductors. Literature shall include specification and description of recommended supporting methods, enclosures or boxes, and wiring connections.

2. One (1) copy of an approved schedule of values to be the basis for all progress payment requests by the Contractor.

C. The following submittals shall be received by the Authority prior to the request for a State Fire Marshal acceptance inspection:

1. One (1) copy each of all installation manuals in hard copy and electronic media.
2. One (1) sample copy of the documentation format for recording the fire alarm system acceptance test. Test document format shall, as a minimum, comply with the requirements of NFPA 72 and individually indicate each addressable initiating device.
3. Half scale (11 inches by 17 inches) contractor record drawings of the system showing all devices, circuit designations and device addresses.

1.10 PROJECT RECORD DOCUMENTS

A. Prior to final payment for the fire alarm system and the beginning of the warranty period, submit the following completed project record documents to the Authority:

1. Copies of all reports for tests and inspections as required by the Authority and Local Agencies.
2. All permits and licenses required to be in the possession of the Owner, the Authority and Local Agencies.
3. Record drawings of the complete installation to include, but not be limited to information required on the installation drawing submittal. All information shall accurately show the completed installation. Record drawings of the floor plans shall be provided in AUTOCAD Release 2013 or later version and also in PDF format. Provide drawings in hard copy and electronic media.
4. Original warranty documents including, but not limited to, those of the fire alarm equipment manufacturer and installing contractor(s). Warranty documents shall reference and be binding to the warranty provisions specified.
5. Copies of all site specific programming on electronic media suitable for downloading into the fire alarm system.
6. Service directory which includes the main 24-hour emergency service number and at least three alternate numbers which are monitored on a 24-hour basis.
7. Three (3) sets of equipment warranties and three (3) set of operations and maintenance instructions to the Owner.

8. Preventive maintenance schedule for the system.

B. Contractor shall provide to the Engineer of Record, in writing, any comments from the local agencies or the Fire Marshal within five (5) working days after the receipt of their comments. Engineer of Record will determine the appropriate actions for response to the comments.

PART 2- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Basis-of-Design Product for FAEM: Subject to compliance with requirements, provide 4010ES Fire Alarm Control Panel by Simplex Grinnell. Do to campus standardization Simplex is the only acceptable manufacturer.

B. Acceptability of the FAEM will be determined only and wholly by the Engineer of Record.

C. All devices and equipment must be manufactured by the FAEM or by listed “OEM” producers for the FAEM.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Fire-alarm control unit and raceways shall withstand the effects of earthquake motions determined according to site classification.

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 and the unit will be fully operational after the seismic event."

2.3 FIRE ALARM CONTROL UNIT (FACU)

A. General: Comply with UL 864, "Control Units and Accessories for Fire Alarm Systems".

B. The following FACU hardware shall be provided:

1. Power Limited base panel with red cabinet and door, 120 VAC input power.
2. Capability to support up to 1,000 addressable devices.
3. 2000 points of annunciation where one (1) point of annunciation equals:

    a. 1 LED driver output on a graphic driver or 1 switch input on a graphic switch input module.
    b. 1 LED on panel or 1 switch on panel.

4. 6 Amp Power Supply minimum with temperature compensated, dual-rate battery charger capable of charging up to 110 Ah batteries without a separate external battery charger. Battery charger voltage and amperage values shall be accessible on the FACU LCD display.

5. 2 Amp Auxiliary Power output with electronic overload protection, automatic restoral, and programmable operation for four-wire detector reset operation.
6. Panel shall be capable of adding 8 conventional zone circuits to connect to existing system devices for ease in retrofit applications.
7. One Auxiliary Relay with Form C contact rated for 2A @32VDC, programmable as a trouble relay, either as normally energized or de-energized, or as an auxiliary control.
8. Four (4) Class B or A Notification Appliance Circuits (NAC; rated 3A@24VDC, resistive). As an option, each NAC shall be configurable for use as auxiliary power taps to control non-reverse polarity devices. Maximum current rating is 2 Amps when used to control auxiliary devices powered from the 24 VDC auxiliary power output.
9. Four (4) form "C" Auxiliary Relay Circuits (Form C contacts rated 2A @ 24VDC, resistive), operation is programmable for trouble, alarm, supervisory of other fire response functions. Relays shall be capable of switching up to ½ A @ 120VAC, inductive.
10. Where required, the FACU shall support up to (5) optional RS-232-C ports. Each RS-232 Port shall be capable of two-way communications.
11. Remote Unit Interface: supervised Class B (Style 4) or Class X (Style 7) signaling line circuit (SLC) for control and monitoring of remotely located annunciators and I/O panels.
12. [Shall provide 48 LED panel mount annunciation with 40 Red and 8 Yellow pluggable LED's. Optional LED kits shall be available for custom LED configurations.][none]
13. Fire Panel Internet Interface to provide supplemental notification and remote user access to the FACU using Ethernet and TCP/IP communications protocol compatible with IEEE Standard 802.3.

C. Cabinet: Lockable steel enclosure. Arrange unit so all operations required for testing or for normal care and maintenance of the system are performed from the front of the enclosure.

D. Alphanumeric Display and System Controls: Panel shall include an 80 character LCD display to indicate alarm, supervisory, and component status messages and shall include a keypad for use in entering and executing control commands.

2.4 FIELD DEVICES

A. Monitor Modules

1. Provide addressable monitor modules where required to interface to contact alarm devices. Provide monitor modules to connect a supervised zone of conventional initiating devices (any normally open dry contact device, including 4-wire smoke detectors) to an intelligent SLC loop. Mount in a 4-inch square electrical box. Wire each zone for Class B, field selectable.
2. Provide address-setting means and store an internal identification code that the control panel shall use to identify the type of device. Provide LED(s) integral to the unit and visible when the unit is installed shall indicate a normal status/power condition (indicating that the monitor module is operational and in regular communication with the control panel). LED(s) integral to the unit and visible when the unit is installed shall indicate that the module activation has been detected.
3. Provide a magnetic test feature to field test the unit for functional operation. Provide an automatic test feature to permit functional testing of the device from the main control panel. Indicate results of the test on the LCD display.

B. Control Modules

1. Provide control/relay modules where required to provide audible alarm interface and/or relay control interface. Provide control modules to connect a supervised zone of conventional indicating devices (any 24 volt DC polarized notification appliance) to an intelligent loop. Mount in a standard 4-inch electrical box. Wire each zone Class B, field selectable. The control module may be optionally wired as a dry contact (Form C) relay. Provide power for the relay actuation from the intelligent detector loop to reduce wiring connection requirements. Provide notification device power from a separate loop from the main control panel or from supervised remote power supplies.
2. Provide address-setting means and store an internal identification code that the control panel shall use to identify the type of device. Provide LED(s) integral to the unit and visible when the unit is installed. It shall indicate a normal status/power condition (indicating that the monitor module is operational and in regular communication with the control panel). LED(s) integral to the unit and visible when the unit is installed shall indicate that a change of state to the module output has occurred.

C. Intelligent Photoelectric Smoke Detectors

1. Provide analog photoelectric smoke detectors. Provide detectors utilizing the photoelectric principal to measure smoke density and, on command from the control panel, send data to the panel representing the ANALOG level of smoke density. Provide automatic sensitivity "drift" compensation to provide long term stability and reliability. Provide a "maintenance alert" feature whereby the detector initiates a trouble condition should the unit’s sensitivity approach the outside limits of the normal sensitivity window. Provide the detector with extensive RF and EMF noise reduction circuitry. Provide self-compensating solid state LED light source and photosensitive circuitry.
2. Provide a calibrated test method whereby the detectors 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 the detector magnetic test switch, or may be activated remotely on command from the control panel.
3. Provide address-setting means and store an internal identification code for each detector that the control panel can use to identify the type and precise location of the detector.
4. Provide LED(s) integral to the unit and visible when the unit is installed. LED(s) shall indicate a normal status/power condition (indicating that the detector is operational and in regular communication with the control panel). LED(s) integral to the unit and visible when the unit is installed shall indicate that an alarm condition has been detected.

5. Provide an output connection in the base to connect an external remote alarm LED.
6. Provide semi-flush ceiling mounted, modular detector head with twist-lock base. Provide in smooth white finish, and back-sealed against dirt, vermin, and back pressure. Provide with fine mesh insect/contaminate screen. Provide UL listing with respective control panel.

D. Intelligent Thermal Detectors

1. Provide analog thermal detectors. Provide detectors utilizing dual electronic thermostats to measure temperature levels in its chamber and, on command from the control panel, send data to the panel representing the analog temperature level.
2. Thermal detectors installed in elevator hoistways or elevator equipment rooms that are to be programmed to initiate elevator power shunt-trip on alarm shall actuate in accordance with the UL standards for a "rate-of-rise" thermal detector. Combination "rate-of-rise" and "fixed temperature" activation is acceptable. "Fixed Temperature" activation of the detector shall be designed to occur prior to release of water by adjacent automatic sprinklers.
3. Provide a calibrated test method whereby detectors 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 may be activated remotely on command from the control panel.
4. Provide address-setting means and store an internal identification code for each detector that the control panel can use to identify the type and precise location of the detector.
5. Provide LED(s) integral to the unit and visible when the unit is installed. LED(s) shall indicate a normal status/power condition (indicating that the detector is operational and in regular communication with the control panel). LED(s) integral to the unit and visible when the unit is installed shall indicate that an alarm condition has been detected.
6. Provide an output connection in the base to connect an external remote alarm LED.
7. Provide semi-flush, ceiling mounted, modular detector head with twist-lock base. Provide in smooth white finish, and be sealed against dirt, vermin and back pressure. Provide with fine mesh insect/contaminate screen. Provide U.L. listing with respective control panel.

E. Intelligent Duct Detectors

1. Provide duct mounted intelligent photoelectric smoke detectors. Provide the same type of detection head as specified by the "Intelligent Photo-electric Smoke Detectors" Paragraphs in this specification. Provide units capable of interchanging/accepting either photoelectric or ionization type sensors. Provide detectors operating in air velocities of 300 fpm to 4,000 fpm without adverse effects on detector sensitivity. Provide detectors that communicate directly with the fire alarm control panel without the use of monitor, control or power modules.
2. Provide a molded plastic enclosure with integral conduit knockouts. Provide housing with gasket seals to insure proper seating of the housing to the associated ductwork. Provide sampling tubes that extend a minimum of seventy-five percent (75%) across the width of the duct. Provide porosity filters to reduce sensor/ chamber contamination. Provide with integral SPDT auxiliary control contacts.
3. Provide a calibrated test method whereby the detectors will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at a remote test station consisting of a key operated switch and indicating LED, or may be activated remotely on command from the control panel.
4. Provide address-setting means and store an internal identification code for each detector that the control panel can use to identify the type and precise location of the detector.
5. Provide LED(s) integral to the unit and visible when the housing is installed and closed. LED(s) shall indicate a normal status/power condition (indicating that the detector is operational and in regular communication with the control panel). LED(s) integral to the

unit and visible when the unit is installed shall indicate that an alarm condition has been detected. LED(s) that are mounted on separate plates and at locations remote from the detector are not required.

6. Duct detector housing shall have ports that can be opened for testing of the duct smoke detector. Placement of the ports shall permit testing personal to measure air flow in the detector housing without removing the duct detector cover. Placement of the ports shall permit testing personnel to insert smoke into the duct detector housing without removing the duct detector cover.
7. Duct detectors that are not listed with the fire alarm control panel, non-addressable, or are provided as part of the HVAC equipment are not permitted.

F. Carbon Monoxide Detectors

1. General: Carbon monoxide detector listed for connection to fire-alarm system.
2. Mounting: Adapter plate for outlet box mounting.
3. Testable by introducing test carbon monoxide into the sensing cell.
4. Detector shall provide alarm contacts and trouble contacts.
5. Detector shall send trouble alarm when nearing end-of-life, power supply problems, or internal faults.
6. Comply with UL 2075.
7. Locate, mount, and wire according to manufacturer's written instructions.
8. Provide means for addressable connection to fire-alarm system.
9. Test button simulates an alarm condition

G. Addressable Manual Pull Stations

1. Provide single action type manual pull stations. On command from the control panel, send data to the panel representing the state of the manual station.
2. Provide address-setting means and store an internal identification code that the control panel can use to identify the type of device.
3. Provide surface mounted stations on standard electrical box. Pull station shall be constructed of hi-impact red molded polycarbonate with instructions for station operation in raised white letters.
4. Reset of manual pull stations may only be accomplished through panel. Local key resets are not acceptable.

H. Visual Devices

1. Provide visual alarm devices operable at 24 volt DC and utilizing a high intensity solid state xenon strobe tube and associated lens/reflector system. Connect the visual devices to supervised circuits.
2. Provide surface mounted, molded of high-impact red thermo plastic.
3. Provide synchronization on all visual devices where there are more than two devices in any field of view, and the devices are not spaced greater than 55 feet from each other. Provide modules in quantities sufficient to synchronize all required devices. Modules shall be capable of synchronizing devices with candela ratings ranging from 15/75 cd to 110 cd.

I. Combination Audible/Visual Devices

1. Provide solid-state electronic audible alarm devices operable at 24 volt DC and polarized supervised. Provide a temporal pattern tone producing a sound pressure level of 91 dBA to 98 dBA. Electro-mechanical solenoids or contacts will not be acceptable.
2. Provide visual alarm devices integral with the audible alarm devices, operable at 24 volt DC, and utilizing a high intensity solid state xenon strobe tube and associated lens/reflector system. Connect the audible/visual devices to supervised circuits.
3. Provide surface mounted, molded of high-impact red thermo plastic.
4. Provide synchronization on all visual devices where there are more than two devices in any field of view, and the devices are not spaced greater than 55 feet from each other. Provide modules in quantities sufficient to synchronize all required devices. Modules shall be capable of synchronizing devices with candela rating from 15/75 cd to 110 cd.

J. Auxiliary Power Supplies:

1. Provide each auxiliary power supply unit in an individual, single, self-contained, lockable cabinet. Input shall be 120 volts AC nominal with an output of regulated 24 volt DC. Unit shall be capable of actuation from either a host panel notification circuit, or programmed dry contacts. Unit shall provide “trouble” indication to host panel upon loss of AC power or abnormal conditions on individual output circuits. Unit shall have a minimum of four (4) output notification circuits rated individually at a minimum of 2 amperes per circuit (minimum). Unit shall be capable of 8 amps total output. Circuiting is based upon auxiliary power supply units of this rating. If units providing equivalent operational features are approved, the Contractor shall be responsible for all redesign, circuiting, or additional equipment costs to provide the necessary output amperage.

K. Exterior Audible Device

1. Provide a solid-state electronic audible alarm device operable at 24 volt DC and polarized supervised. Provide a temporal pattern tone producing a sound pressure level of 91 dBA to 98 dBA. Electro-mechanical solenoids or contacts will not be acceptable. Connect the audible/visual device to a supervised circuit.
2. Provide semi-flush mounted, molded of high-impact red thermo plastic and listed for exterior (weatherproof) installation.

L. Auxiliary Relays

1. Provide relays for ventilating and air handling control interface. Provide heavy duty type rated up to 10 amps at 24 volt DC. Provide with NEMA I dust cover assembly and SPDT contacts.

M. Remote Annunciators

1. Provide a remote annunciator with a minimum eighty (80) character liquid crystal display (LCD) which mimics the fire alarm control panel display. The remote annunciator shall have an enable key for operation of integral acknowledge, rest and silence switches. The remote annunciator shall derive all operational power from the fire alarm control panel.

2.5 CONDUCTORS

A. Initiation, notification and auxiliary device circuit conductors shall be type FPLN, FPLPN, or FPLRN. Where conductors are installed in complete raceway systems, type THHN or TFFN may be used if approved by the manufacturer. Where the size or type of conductor hereinafter specified conflicts with the FAEM's requirements, the larger size or more specialized conductor type shall be used.

B. Conductors for any non-power limited circuits shall be type THHN.

C. Conductors for wet locations shall be:

1. Types RHW, TW, THW, THHW, THWN or XHHW.
2. Type listed for use in wet locations.

2.6 RACEWAY

A. The following raceway types shall permitted:

1. EMT conduit
2. RIGID conduit
3. Non-Metallic conduit for wet locations.
4. Surface mounted metallic race with a minimum size equivalent to 1/2-inch nominal conduit.

B. Boxes, supports, and other accessories for the raceway installation shall be listed for the application.

2.7 WARRANTY

A. Repair all defective workmanship or replace all defective materials for a period of three years from the date of acceptance by the State Fire Marshal or the Authority or designated representative. Workmanship or equipment found to be defective during that period shall be replaced without cost to the Owner.

B. The warranty or any part of the warranty shall not be made void by any required operation or inspection of the system after acceptance during the warranty period. The Owner may, at the Owner's option, select qualified firms other than Warrantor to provide required tests and inspections. System testing and inspections will be conducted only by a duly licensed company under contract with the Owner to perform scheduled testing and inspections as required by the Local Authority. The Warrantor may elect to have a representative present at the scheduled testing during the warranty period.

C. Warranty shall be documented by the issuance of a written service agreement in the name of the Owner.

PART 3- EXECUTION

3.1 COORDINATION WITH OTHER TRADES

A. Coordinate closely with all other trades to expedite construction, accurately interface with related systems and avoid interferences.

3.2 INSTALLATION/APPLICATION

A. Furnish and install all circuit conductors, raceway, and outlet boxes.

B. Furnish and install all back-boxes, fire alarm equipment and fire alarm devices.

1. Back-boxes shall be of the exact type recommended by the FAEM as shown on the equipment and device submittals.
2. Devices and equipment must be installed by personnel legally permitted and currently licensed to install the devices and equipment. The cost of installation, warranty of installation and equipment, coordination of the installation, and supervision of the installation are responsibilities of the Contractor.

C. Open conductors and conduits shall be concealed from public view at all locations by routing on the inside of joists, above lay-in ceilings, over girders, within partitions or in any other manner acceptable to the Owner. All conductors and conduits shall be installed at right angles to the building walls, floors and ceilings.

D. Open conductors and conduits shall be supported in a manner and at intervals compliant with NEC requirements. Conductors and conduits installed above lay-in ceilings shall be supported from the building structure and shall not be permitted less than 9-inches above or behind removable panels or ceiling tiles.

E. All wires shall be tagged at all junction points and shall test free from grounds or crosses between conductors.

F. No other conductors shall be installed in conduits with conductors for the fire alarm system.

G. Final connections between equipment and the wiring system shall be made under direct supervision of a representative of the FAEM. If other personnel are required by the local authorities to be present during final connections, this shall not relieve the Contractor of the responsibility of providing a representative of the FAEM for direct supervision.

H. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.

1. Connect new equipment to existing control panel in existing part of the building.
2. Connect new equipment to existing monitoring equipment at the supervising station.

3. Expand, modify, and supplement existing control equipment as necessary to extend existing control functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.

3.3 EQUIPMENT MOUNTING

A. The control panel shall be surface mounted with no operational parts which may require maintenance mounted greater than 72-inches above the finished floor. The control panel annunciator display and control surface shall be mounted so that no switch, manually operated device, display or LED is greater than 60-inches above the finished floor.

B. Comply with requirements for seismic-restraint devices specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

C. Duct detectors shall be mounted as follows:

1. In the supply and/or return air duct of each HVAC unit of greater than 2,000 cfm capacity. Duct detectors shall be mounted in such a way as to obtain a representative sample of the airstream. Where possible, locate the duct detectors in the zone between 6 and 10 duct widths from any duct bends or inlets.
2. Detectors shall be accessible for cleaning and shall be mounted in accordance with the manufacturer's instructions and NFPA standards. Coordinate placement of the detector with all affected trades and equipment. Connect all circuit conductors that terminate on the detector.
3. All HVAC equipment shutdown shall be initiated by addressable control. Addressable control modules shall be mounted within 3 feet of the motor controller of the affected equipment. Install all control circuits and terminations on the "coil" side of the addressable control modules. Circuits for the "contact" side of the relays shall be by provider of the environmental air controls.
4. Any factory installed or other duct smoke detectors that are not listed for use with the fire alarm system control panel shall be removed and the integrity of the ductwork and HVAC unit shall be maintained.

D. Addressable control and monitor modules shall be mounted within 3 feet of the motor controller or output contacts of the affected equipment. Modules shall be mounted in an appropriate box or enclosure with cover. Cover shall be labeled with the module address and description of the monitored or controlled equipment.

E. The remote annunciator shall be mounted so that no switch, manually operated device, display, or LED is greater than 60-inches above the finished floor. The remote annunciator shall be located at the entrance designated for responding personnel or as otherwise acceptable to the Authority.

F. Manual pull stations shall be securely mounted with the operable part of the manual pull station no greater than 48-inches above the finished floor and no less than 42-inches above the finished floor. All manual stations, except those installed in mechanical rooms, shall be provided with hinged, sounding poly-carbonate covers.

G. Audible/visual and visual devices shall be wall-mounted with their bottoms at 80-inches above the finished floor or 6-inches below the ceiling, whichever is lower. Audible/visual and visual devices in the following locations shall be provided with vandal-resistant covers.

1. Corridors, student restrooms and locker rooms of high schools and middle schools.
2. Gymnasiums of all schools.

H. Weatherproof audible/visual notification devices shall be mounted (at the fire department connection on the building exterior and with the final location) as acceptable to the AHJ.

I. All Door release hardware shall be activated by addressable control modules. Relays shall be mounted within 3 feet of the affected door release device. Install all control circuits and terminations on the "coil" side of the relays or modules. Connections and circuits for the "contact" side of the relays shall be by provider of the door holder non-power limited circuits.

J. Devices shall not be supported by ceiling tiles. Devices must be attached to back-box supported by the ceiling grid.

K. Smoke detectors shall be installed in accordance with the manufacturer's recommendations, applicable code requirements, and the following:

1. Smoke detectors shall not be installed within thirty-six (36) inches of air discharge registers or intake registers unless the detectors are installed for the purposes of monitoring return air.
2. Smoke detectors shall not be mounted on beams or soffits protruding more than twelve (12) inches below the ceiling height.
3. Smoke detectors in corridors and common areas (high schools and middle schools only) shall be provided with vandal-resistant covers.

3.4 CUTTING, PATCHING AND FINISHES

A. All fire alarm raceway shall be thoroughly cleaned, removing all dirt, oil, etc. and made ready to receive paint.

1. All fire alarm raceway exposed in mechanical rooms, or exposed in attics or other unfinished areas shall be painted red with enamel designed for covering metal or the other raceway material.
2. All fire alarm raceway exposed in finished areas shall be painted to match the adjacent existing finish or finished as more specifically described below:

B. Employ a skilled and experienced installer to perform cutting and patching new Work; restore Work with new Products.

C. Submit written request to Owner in advance of cutting or altering structural or building enclosure elements.

D. Holes in walls or floors cut during the performance of this work and all holes or cuts revealed by the removal of existing fire alarm system devices, equipment or circuits shall be patched or

covered with standard escutcheon plates so as to completely conceal the cuts where they would otherwise be exposed to view.

E. Provide final finishes to match the existing finish of the existing adjacent surfaces so as o completely conceal patched holes.

F. Fire stop all penetrations of fire rated assemblies with listed fire-stopping systems.

3.5 SYSTEM TESTS

A. Upon complete installation system is to be tested 100% in the presence of Architect or Architect's agent, and owner's representative.

B. All test and inspections specified in this section shall be reported in writing and submitted in accordance with this specification section.

C. Provide a complete pre-test of the fire alarm system, including fire safety control functions prior to the acceptance testing. Sufficient documentation of the pre-test shall be provided to verify that tests are thorough and performed using the proper methods and equipment. Smoke detectors shall be tested using smoke simulation products.

D. The acceptance tests for the system shall meet all the requirements of the listed applicable codes and the requirements of the Fire Marshal. The system tests, test methods, and test documents, including those required for and by the central station, shall meet the requirements of the Authority and the Fire Marshal.

E. Any additional costs resulting from improper system operation during acceptance testing shall be the responsibility of and paid for by the Contractor. This includes, but is not limited to costs associated with the attendance by the Fire Marshal, Authority, OR ngineer of Record.

F. All testing, inspection and retesting required for certification and required for all warranty work or replacements shall meet the requirements of the Authority and Fire Marshal. This certification, inspection, or testing shall be completed at no additional cost.

G. Provide the testing date and Fire Marshal's "Public School Fire Alarm Pre-inspection Checklist." completed in writing to the Fire Marshal a minimum of two weeks before the date. The Owner may, at the Owner's option, have a representative present for testing.

H. The fire alarm system will not be acceptable until final testing and receipt of the testing certificates have been obtained.

3.6 RECEIVING AND HANDLING

A. The Contractor shall be responsible for all receiving, handling and storage of his materials at the job site.

B. Use of loading docks, service driveways, and freight elevators shall be coordinated with the Owner.

3.7 ADDITIONAL DEVICES

A. Contractor to provide up to 20% additional installed devices as necessary to comply with sound pressure and A/V deficiencies discovered during testing

B. Contractor to supply owner with the following spare parts:

1. One pull station
2. One horn/strobe
3. One monitor module
4. One smoke detector
5. One heat detector

3.8 RUBBISH REMOVAL

A. Contractor shall remove rubbish and debris resulting from his work on a daily basis from the work site. Rubbish not removed by the Contractor may be removed by the Architect and back-charged to the Contractor.

END OF SECTION 283100

SECTION 311000 - SITE CLEARING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Clearing and protection of vegetation.

B. Removal of existing debris.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate work with utility companies; notify before starting work and comply with their requirements; obtain required permits.

1.3 QUALITY ASSURANCE

A. Clearing Firm: Company specializing in the type of work required.
   1. Minimum of three years of documented experience.

PART 2 PRODUCTS

2.1 MATERIALS

A. Fill Material: As specified in Section 31 2300.

PART 3 EXECUTION

3.1 PREPARATION

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

B. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.

C. Utility Locator Service: Notify New Mexico 811 before site clearing.

D. Do not commence site clearing operations until temporary erosion and sedimentation-control and plant protection measures are in place.

E. Protect and maintain benchmarks and survey control points from disturbance.

F. Protect site improvements to remain from damage. Restore damaged improvements to condition existing before start of site clearing.

G. Do not store materials or equipment or permit excavation within drip line of remaining trees.

H. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to the Erosion Control Drawings, as approved by local jurisdiction.
   1. See Section 01 5713 - Temporary Erosion and Sediment Control, for additional requirements.

I. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed.

3.2 SITE CLEARING

A. Comply with other requirements specified in Section 01 7000.

B. Minimize production of dust due to clearing operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.

C. Protect remaining trees and shrubs from damage and maintain vegetation. Employ a licensed arborist to repair tree and shrub damage. Restore damaged vegetation. Replace damaged trees that cannot be restored to full growth, as determined by arborist.

D. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction. Removal includes digging out stumps and obstructions and grubbing roots.

E. Strip topsoil. Stockpile topsoil that will be reused in the Work.
   1. Stockpile surplus topsoil to allow for respreading deeper topsoil.

F. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.

G. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
   1. Neatly saw-cut length of existing pavement to remain before removing existing pavement.

H. In areas not to be further excavated, fill depressions resulting from site clearing. Place and compact satisfactory soil materials in 8-inch-thick layers to density of surrounding original ground.

I. Dispose of waste materials, including trash, debris, and excess topsoil, off Owner's property. Burning waste materials on-site is not permitted.
   1. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities.

3.3 EXISTING UTILITIES AND BUILT ELEMENTS

A. Protect existing utilities to remain from damage.

B. Do not disrupt public utilities without permit from authority having jurisdiction.

C. Protect existing structures and other elements that are not to be removed.

3.4 VEGETATION

A. Scope: Remove trees, shrubs, brush, and stumps in areas to be covered by building structure, paving, and planting beds.

B. Do not begin clearing until vegetation to be relocated has been removed.

C. Install substantial, highly visible fences at least 3 feet high to prevent inadvertent damage to vegetation to remain.
   1. At vegetation removal limits.
   2. Around trees to remain within vegetation removal limits; locate no closer to tree than at the drip line.
   3. Around other vegetation to remain within vegetation removal limits.
   4. See Section 01 5000 for fence construction requirements.

D. In areas where vegetation must be removed but no construction will occur other than pervious paving, remove vegetation with minimum disturbance of the subsoil.

E. Locate and clearly flag trees and vegetation to remain or to be relocated.

F. Vegetation Removed: Do not burn, bury, landfill, or leave on site.
   1. Chip, grind, crush, or shred vegetation for mulching, composting, or other purposes; preference should be given to on-site uses.
   2. Trees: Sell if marketable; if not, treat as specified for other vegetation removed; remove stumps and roots to depth of 18 inches.
   3. Existing Stumps: Treat as specified for other vegetation removed; remove stumps and roots to depth of 18 inches.
   4. Sod: Re-use on site if possible; otherwise sell if marketable, and if not, treat as specified for other vegetation removed.
   5. Fill holes left by removal of stumps and roots, using suitable fill material, with top surface neat in appearance and smooth enough not to constitute a hazard to pedestrians.

G. Restoration: If vegetation outside removal limits or within specified protective fences is damaged or destroyed due to subsequent construction operations, replace at no cost to Owner.

3.5 DEBRIS

A. Remove debris, junk, and trash from site.

B. Leave site in clean condition, ready for subsequent work.

C. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION 311000

SECTION 312300 - EARTHWORK

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Rough grading the site for site structures and building pads.

B. Excavating for footings, slabs-on-grade, paving, site structures, and utilities within the building.

C. Filling, backfilling, and compacting for footings, slabs-on-grade, paving, site structures, and utilities within the building.

D. Trenching for utilities outside the building to utility main connections.

E. Backfilling and compacting for utilities outside the building to utility main connections.

1.2 RELATED SECTIONS

A. Document 00 3100 - Available Project Information: Geotechnical report; bore hole locations and findings of subsurface materials.

1.3 DEFINITIONS

A. Finish Grade Elevations: Indicated on Drawings.

B. Subgrade Elevations: Indicated on Drawings.

1.4 REFERENCE STANDARDS

A. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

B. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).

C. ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.

D. ASTM D2940/D2940M - Standard Specification for Graded Aggregate Material for Bases or Subbases for Highways and Airports.

E. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

F. ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

1.5 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate requirements for special foundations and load bearing elements specified in other Sections.

B. Preinstallation Meeting: Conduct a preinstallation meeting minimum one week prior to the start of the work of this Section; require attendance by all affected installers, and Owner's geotechnical engineering consultant.
   1. Convene under general provisions of Section 01 7000.
   2. Discuss all earthwork requirements specified, and document any additional requirements or modified requirements received from Owner and Owner's geotechnical engineer which require a modification of the Contract.

1.6 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Samples: 50 lb sample of each type of fill; submit in air-tight containers to testing laboratory.

C. Materials Sources: Submit name of imported materials source.

D. Fill Composition Test Reports: Results of laboratory tests on proposed and actual materials used.

E. Compaction Density Test Reports.

F. Project Record Documents: Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.

1.7 DELIVERY, STORAGE, AND HANDLING

A. When necessary, store materials on site in advance of need.

B. Locate stockpiles where designated.
   1. Separate differing materials with dividers or stockpile separately to prevent intermixing.
   2. Prevent contamination.
   3. Protect stockpiles from erosion and deterioration of materials.

PART 2 PRODUCTS

2.1 MATERIALS - GENERAL

A. Soil materials, whether from sources on or off site must be approved by Owner's geotechnical engineer as suitable for intended use, and from same source throughout.

2.2 MATERIALS

A. Engineered Fill: On-site or imported soils consisting of crushed stone, crushed or screened gravel, caliche, and/or sand; free of vegetable matter and all other deleterious materials, including silt and clay balls; maximum liquid limit of 35 and plasticity index of 4 minimum to 15 maximum in accordance with ASTM D4318.
   1. Applications: All fill and backfill applications, unless otherwise specified.

2. Graded in accordance with ASTM C136, within the following limits:
   a) 2 inch Sieve: 100 percent passing
   b) 1/2 inch Sieve: 30 to 80 percent passing.
   c) No. 4 Sieve: 20 to 60 percent passing.
   d) No. 200 Sieve: 5 to 20 percent passing.

B. Controlled Fill: On-site or imported soils consisting of crushed stone, crushed or screened gravel, caliche, and/or sand; free of vegetable matter and all other deleterious materials, including silt and clay balls; 2-1/2 inch maximum particle size; liquid limit of 35 maximum and plasticity index of 4 minimum to 15 maximum in accordance with ASTM D4318.
   1. Applications: Non-load bearing embankments.

C. Imported Granular Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; free of clay, shale, organic matter.
   1. Graded in accordance with ASTM C136, within the following limits:
      a) 1 inch Sieve: 100 percent passing
      b) No. 200 Sieve: 8 percent passing.

2.3 SOURCE QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for general requirements for testing and analysis of soil material.

B. Where fill materials are specified by reference to a specific standard, test and analyze samples for compliance.

C. If tests indicate materials do not meet specified requirements, change material and retest.

D. Provide materials of each type from same source throughout the work.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that survey bench marks and intended elevations for the work are as indicated.

B. Verify damp proofing installation has been inspected.

C. Verify structural ability of unsupported walls to support imposed loads by the fill.

3.2 PREPARATION

A. Identify required lines, levels, contours, and datum locations.

B. Locate, identify, and protect from damage above- and below-grade utilities that remain.

C. Protect site features to remain, including but not limited to bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs, from damage by grading equipment and vehicular traffic.

D. Protect trees to remain by providing substantial fencing around entire tree at the outer tips of its branches; no grading is to be performed inside this line.

E. Protect plants, lawns, and other features to remain as a portion of final landscaping.

F. Remove very loose Stratum 1 soils over entire site and from areas to be further excavated, re-landscaped, or re-graded, without mixing with foreign materials.

G. Proof roll entire site; minimum 5 passes with heavy vibratory roller to observe for unsuitable or weak soils; observed by Owner's geotechnical engineering consultant.

3.3 SOIL STOCKPILING

A. Excavate very loose Stratum 1 silty clayey sand topsoil in building pad and paving areas to uniform depth; thickness varies.
   1. Remove excavated material that is unsuitable for re-use from site.
   2. Remove excess excavated material from site.

B. Proof roll initially excavated areas; minimum 5 passes with heavy vibratory roller to identify unsuitable or weak soils; observed by Owner's geotechnical engineering consultant.

C. Stockpiling:
   1. Stockpile excavated topsoil to be re-used on site; remove remainder from site.
   2. Stockpile excavated subsoil to be re-used on site; remove remainder from site.
   3. Stockpiles: Use areas designated on site; pile depth not to exceed 8 feet; protect from erosion.

D. Use of explosives is not permitted.

3.4 EXCAVATING

A. Perform additional excavation, if necessary, to accommodate new structures and construction operations.

B. Excavate subsoil required for building pad to depths required for footing bearing on undisturbed natural caliche or minimum 12 inches of engineered fill, and to a depth of 16 inches below bottom of floor slab elevation, and to a point 5 feet beyond the building line.
   1. Excavate for utilities trenches, construction operations, and other work as specified in this Section and other Sections.
   2. Notify Architect of unexpected subsurface conditions and discontinue affected work in area until notified to resume work.

C. Slope banks of excavations deeper than 4 feet to angle of repose or less until shored.

D. Do not interfere with 45 degree bearing splay of foundations.

E. Hand trim excavations. Remove loose matter.

F. Correct areas that are over-excavated and load-bearing surfaces that are disturbed.

G. Grade top perimeter of excavation to prevent surface water from draining into excavation.

H. Excavate to required subgrade elevations for vehicular paving areas. Coordinate depth of excavations based on indicated paving sections.

I. Prepare excavated building pad and paving areas prior to backfilling; scarify subgrade surfaces to a depth of minimum 12 inches.
   1. Cut out soft areas of subgrade not capable of compaction in place. Backfill with engineered fill.
   2. Compact subgrade to density equal to or greater than requirements for subsequent fill material.
   3. Until ready to fill, maintain excavations and prevent loose soil from falling into excavation.

3.5 TRENCHING

A. Slope banks of excavations deeper than 4 feet to angle of repose or less until shored.

B. Do not interfere with 45 degree bearing splay of foundations.

C. Cut trenches wide enough to allow inspection of installed utilities.

D. Cut out soft areas of subgrade not capable of compaction in place. Backfill with general fill.

E. Compact subgrade to density equal to or greater than requirements for subsequent fill material.

F. Until ready to backfill, maintain excavations and prevent loose soil from falling into excavation.

G. Remove large stones and other hard matter that could damage piping or impede consistent backfilling or compaction.

3.6 BACKFILLING

A. Backfill to contours and elevations indicated using unfrozen materials.

B. Employ a placement method that does not disturb or damage other work.

C. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.

D. Moisture Content: Maintain moisture content of fill and backfill materials, expressed as a percentage in relation to optimum moisture content, to attain required compaction density.
   1. All Specified Soils: Plus 2 percent to minus 2 percent.
   2. Protect moisture content of prepared soil materials from moisture loss at all times.

E. Fill Lift Thickness:
   1. Engineered and Controlled Soil Fill: Place and compact material in equal continuous layers not exceeding 8 inches loose depth.

F. Correct areas that are over-excavated.
   1. All Areas: Use engineered fill, flush to required elevation, compacted to minimum 95 percent of maximum dry density.

G. Compaction Density Unless Otherwise Specified or Indicated (ASTM D698):
   1. At All Locations: 95 percent of maximum dry density.

H. Reshape and re-compact fills subjected to vehicular traffic.

3.7 BEDDING AND FILL AT SPECIFIC LOCATIONS

A. General: Comply with local jurisdiction requirements for earthwork bedding and fill work in public rights-of-way.

B. The paragraphs below identify location, fill material to be used (identified from lower to upper fill type), and compacted thickness of each fill:

C. Utility Piping, Conduits, Duct Bank, and Similar Items:
   1. Bedding: Use engineered fill.
   2. Backfill: Cover with engineered fill.
   3. Fill up to subgrade elevation.

D. At Interior Slab-on-Grade:
   1. Use engineered fill.
   2. Fill 10 inches deep.
   3. Fill up to subgrade elevation.
   4. Place 6 inch thick layer of imported granular fill.
   5. Place vapor retarder over finished subgrade as specified in Section 03 3000.

E. At Exterior Side of Foundation Walls and Retaining Wall Backfill:
   1. Use engineered fill.
   2. Fill up to subgrade elevation.

F. Fill Under Footings and Foundations:
   1. Use minimum 12 inches of engineered fill if necessary to establish required bearing elevations.
   2. Fill up to required subgrade elevation.

G. Fill Under Exterior Concrete Walks and Pedestrian Paving:
   1. Use engineered fill to establish subgrade elevations.
   2. Fill up to subgrade elevation.

H. Fill Under Asphalt and Concrete Vehicular Paving:
   1. Use engineered fill if required to establish subgrade elevations.
   2. Fill up to subgrade elevation.
   3. Place aggregate base course to thickness indicated on Drawings.

I. Fill Under Landscaped Areas and Non-Load Bearing Areas:
   1. Use engineered fill or controlled fill.
   2. Fill up to subgrade elevation.

3.08 FINISH GRADING

A. Before Finish Grading:
   1. Verify building and trench backfilling have been inspected.

2. Verify subgrade has been contoured and compacted.

B. Remove debris, roots, branches, stones, in excess of 1/2 inch in size. Remove soil contaminated with petroleum products.

C. In areas where vehicles or equipment have compacted soil, scarify surface to depth of 3 inches.

D. Complete finish grading to elevations and slopes indicated.

3.9 REPAIR AND RESTORATION

A. Existing Facilities, Utilities, and Site Features to Remain: If damaged due to this work, repair or replace to original condition.

B. Trees to Remain: If damaged due to this work, trim broken branches and repair bark wounds; if root damage has occurred, obtain instructions from Architect as to remedy.

C. Other Existing Vegetation to Remain: If damaged due to this work, replace with vegetation of equivalent species and size.

3.10 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for general requirements for field inspection and testing.

B. Provide for visual inspection of load-bearing excavated surfaces before placement of foundations.

C. Compaction density testing will be performed on compacted fill in accordance with ASTM D1556 or ASTM D3017.

D. Results will be evaluated in relation to compaction curve determined by testing un-compacted material in accordance with ASTM D698 ("standard Proctor").

E. If tests indicate work does not meet specified requirements, remove work, replace and retest.

F. Frequency of Tests:
1. Conduct at least one test for each strata of soil on which foundations will be placed, to verify required design bearing capacities.
2. Prior to start of fill work at building pad, conduct field density tests of bottom of building pad excavation, at each column footing location, and one density test for each 100 lineal feet of continuous spread footing.
3. Conduct one field density test of top 12 inches of subgrade for every 5,000 square feet of paved area or building slab. Provide additional tests in each compacted fill layer for fills exceeding 30 inches in depth.
4. Conduct at least one field density test for foundation wall backfill at bottom and top lifts, and not less than one set of tests for each 100 lineal feet of backfill.
5. Conduct at least one field density test for each 100 cubic yard of backfill for trenches at bottom, middle, and top lifts, and not less than one set of tests for each 100 lineal feet of trench.

3.11 PROTECTION

A. Prevent displacement of banks and keep loose soil from falling into excavation; maintain soil stability.

B. Protect bottom of excavations and soil adjacent to and beneath foundation from freezing.

3.12 MAINTENANCE

A. Protect newly graded areas from traffic and erosion. Keep free of trash and debris.

B. Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerance.

C. Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, re-shape, and compact to required density prior to further construction.

D. Where settling is measurable or observable at excavated areas during general project warranty period, remove surface (pavement, lawn, or other finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.13 TOLERANCES

A. Top Surface of Subgrade: Plus or minus 0.10 foot (1-3/16 inches) from required elevation.

B. Top Surface of Finish Grade: Plus or minus 0.04 foot (1/2 inch).

3.14 CLEANING

A. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.

B. Leave site clean and raked, ready to receive landscaping.

END OF SECTION 312300

SECTION 321216 - ASPHALT PAVING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Aggregate base course.

B. Bituminous concrete paving.

1.2 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Mix Design: Submit proposed mix design of each class of mix for review prior to commencement of work.

C. Certificates: Submit two copies of material certificates signed by the material producer and Contractor, certifying that each material item complies with specified requirements.
   1. If requested, submit independent testing laboratory reports on aggregates and asphalt for sieve analysis, wear abrasion and other specified characteristics.

D. Project Record Documents: Maintain record of time and date of placement, temperature and weather conditions at time of placement.

1.3 QUALITY ASSURANCE

A. Perform work in accordance with applicable requirements of New Mexico State Highway and Transportation Department Standard Specifications for Highway and Bridge Construction, 2014 Edition; Section 423.

B. Obtain materials from same source throughout.

1.4 REGULATORY REQUIREMENTS

A. Conform to applicable code for paving work on public property.

1.5 DELIVERY, STORAGE, AND PROTECTION

A. Transport mixtures from mixing plant in trucks with tight, clean, non-sticking compartments. Provide covers to protect from weather and to prevent loss of heat when ambient temperature is below 50 degrees F.

1.6 FIELD CONDITIONS

A. Do not place asphalt when ambient air or base surface temperature is less than 40 degrees F, or surface is wet or frozen.
   1. Exception: Ambient temperature must be above 50 degrees F for the final asphalt wearing surface.

B. Place bitumen mixture when temperature is not more than 15 degrees F below bitumen supplier's bill of lading and not more than maximum specified temperature.

PART 2 PRODUCTS

2.1 MATERIALS

A. Aggregate Materials - General: Comply with regionally-sourced and recycled content product requirements specified in Section 01 6000.

B. Asphalt Cement Materials: In accordance with New Mexico State Highway and Transportation Department Standard Specifications for Highway and Bridge Construction, 2014 Edition.

C. Aggregate for Base Course: In accordance with New Mexico State Highway and Transportation Department Standard Specifications for Highway and Bridge Construction, 2014 Edition; Section 303, Table 303.2.1.1.

D. Mineral Aggregate: In accordance with New Mexico State Highway and Transportation Department Standard Specifications for Highway and Bridge Construction, 2014 Edition; SP IV requirements, Table 423.2.2.1:1.

2.2 ASPHALT PAVING MIXES AND MIX DESIGN

A. Use dry material to avoid foaming. Mix uniformly.

B. Perform mix design using HMA Superpave Mix Design method according to In accordance with New Mexico State Highway and Transportation Department Standard Specifications for Highway and Bridge Construction, 2014 Edition, Table 423.2.8.1.

C. Submit proposed mix design of each class of mix for review prior to beginning of work.

2.3 ACCESSORIES

A. Herbicide: Chemical root inhibitor.

B. Pavement Marking Paint: Specified in Section 32 1723.13.

2.4 SOURCE QUALITY CONTROL

A. Test mix design and samples in accordance with New Mexico State Highway and Transportation Department Standard Specifications for Highway and Bridge Construction, 2014 Edition.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that compacted subgrade is dry and ready to support paving and imposed loads.

B. Verify gradients and elevations of base are correct.

3.2 PREPARATION - BASE SOILS

A. Coordinate compaction of soil base with Section 31 2300.

B. Proof roll areas to be paved with pneumatic tired equipment with a minimum vehicle weight of 25 tons. Where soft areas occur, remove loose materials and replace with base course aggregate compacted to level of subgrade.

C. Verify accuracy of site grading will result in minimum specified base course and asphalt thicknesses. Identify necessary refinements and modifications which may be necessary for proper drainage.

D. Apply herbicide at rate recommended by manufacturer; full coverage over paved areas. Remove surface vegetation within three days prior to application. Limit application of sterilant only to pavement areas.

3.3 PREPARATION - BASE COURSE

A. Place and compact base course as specified.

3.4 PREPARATION – PAVEMENT

A. Coat surfaces of manhole and catch basin frames, and similar items, with oil to prevent bond with asphalt pavement. Do not tack coat these surfaces.

3.5 PLACING ASPHALT PAVEMENT

A. Install Work in accordance with New Mexico State Highway and Transportation Department Standard Specifications for Highway and Bridge Construction, 2014 Edition.

B. Place asphalt within 24 hours of applying primer or tack coat.

C. Do not locate seams on vehicle wheel lines parallel to the direction of traffic.
D. Compact pavement by rolling to specified density. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment.

E. Perform rolling with consecutive passes to achieve even and smooth finish without roller marks.

3.6 PAVEMENT PATCHING

A. Cut and fill with fresh, hot asphaltic concrete. Remove deficient areas for full depth of surface and base course.

B. Cut sides vertically, perpendicular and parallel to direction of traffic for extent of failure.

C. Compact and finish as specified.

D. Patch test holes full depth of section and finish flush with adjoining work.

E. Where patching is required in rights-of-way or on public property, patch as required by local jurisdiction, but not less than minimum requirements of this Section.

3.7 INSTALLATION – ACCESSORIES

A. Pavement Marking Paint: Apply according to Section 32 1723.13.

3.8 TOLERANCES

A. Flatness: Maximum variation of 1/8 inch measured with 10 foot straight edge.

B. Compacted Thickness: Within 1/4 inch of specified or indicated thickness.

C. Variation from True Elevation: Within 1/2 inch.

3.9 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for general requirements for quality control.

B. Include tests for compaction and thickness of entire pavement section and each course as installation progresses.

C. Testing organization will take samples and perform tests in accordance with New Mexico State Highway and Transportation Department Standard Specifications for Highway and Bridge Construction, 2014 Edition.

3.10 PROTECTION

A. Immediately after placement, protect pavement from mechanical injury for 7 days or until surface temperature is less than 140 degrees F.

END OF SECTION 321216

SECTION 321313 - CONCRETE PAVING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Concrete sidewalks, stair steps, gutters, parking areas, and similar site elements.

1.2 REFERENCE STANDARDS

A. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete; American Concrete Institute International.

B. ACI 301 - Specifications for Structural Concrete; American Concrete Institute International.

C. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete; American Concrete Institute International.

D. ACI 305R - Hot Weather Concreting; American Concrete Institute International.

E. ACI 306R - Cold Weather Concreting; American Concrete Institute International.

F. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.

G. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.

H. ASTM C33/C33M - Standard Specification for Concrete Aggregates.

I. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.

J. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete.

K. ASTM C150/C150M - Standard Specification for Portland Cement.

L. ASTM C173/C173M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.

M. ASTM C260/C260M - Standard Specification for Air-Entraining Admixtures for Concrete.

N. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.

O. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete.

P. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.

Q. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).

R. ASTM D1752 - Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.

1.3 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data on joint filler, admixtures, and curing compound.

C. Mix Designs: Submit proposed mix design for each class of concrete specified. Include proportions of ingredients, aggregate analysis, cement brand and type, slump, water/cement ratio, and strength test reports for 7 and 28 day strengths.
   1. Prepare in accordance with ACI 301.
   2. Provide specific aggregate analysis for recycled aggregates proposed for use in concrete mixes.
   3. Fly-Ash Content Submittal: If any fly ash or ground granulated blast furnace slag is used in mix designs to replace Portland cement, submit the total volume of concrete cast in place, mix design(s) used showing the quantity of Portland cement replaced, reports showing successful cylinder testing, and temperature on day of pour if cold weather mix is used.

PART 2 PRODUCTS

2.1 PAVING ASSEMBLIES

A. Comply with applicable requirements of New Mexico State Highway and Transportation Department Standard Specifications for Highway and Bridge Construction, 2014 Edition; Section 450.
   1. Proofrolling and Base Course for Concrete Paving: Specified in Section 31 1216.

2.2 MATERIALS - GENERAL

A. Formwork, Reinforcing, and Concrete Materials - General: Comply with applicable recycled content and sustainably harvested wood product requirements specified in Section 01 6000.

2.3 FORM MATERIALS

A. Form Materials: Conform to ACI 301.

B. Joint Filler: Preformed; non-extruding bituminous type (ASTM D1751) or sponge rubber or cork (ASTM D1752).
   1. Thickness: 1/2 inch.

2.4 REINFORCEMENT

A. Reinforcing Steel: ASTM A615/A615M, Grade 40 (40,000 psi) yield strength; deformed billet steel bars; unfinished.

B. Steel Welded Wire Reinforcement: Plain type, ASTM A1064/A1064M; in flat sheets; unfinished.

2.5 CONCRETE MATERIALS

A. Obtain cementitious materials from same source throughout.

B. Cement: ASTM C150/C150M, Air Entraining - Type IIA or Type V - Sulfate-Resistant, Portland type, gray color.

C. Fine and Coarse Mix Aggregates: ASTM C33/C33M.

D. Fly Ash: ASTM C618, Class F or C.

E. Water: Clean, and not detrimental to concrete.

F. Air-Entraining Admixtures: ASTM C260/C260M.

G. Color Additive: Pure, concentrated mineral pigments specifically intended for mixing into concrete and complying with ASTM C979.
   1. Color(s): To match Architect's sample(s) when incorporated into specified mix design(s).
   2. Acceptable Manufacturers:
      a. BRICKFORM: www.brickform.com.
      b. Butterfield Color: www.butterfieldcolor.com.
      c. Davis Colors: www.daviscolors.com.
      d. Lambert Corporation: www.lambertusa.com.
      e. Solomon Colors: www.solomoncolors.com.
      f. Substitutions: See Section 01 6000 - Product Requirements.

H. Chemical Admixtures: ASTM C494/C494M, Type A - Water Reducing.
   1. Do not use chemicals that will result in soluble chloride ions in excess of 0.1 percent by weight of cement.

2.6 ACCESSORIES

A. Curing Compound: ASTM C309, Type 2 (white pigmented), Class A.

B. Joint Sealer: Specified in Section 07 9200.

2.7 CONCRETE MIX DESIGN

A. Proportioning Normal Weight Concrete: Comply with ACI 211.1 recommendations.

B. Concrete Strength: Establish required average strength for each type of concrete on the basis of field experience or trial mixtures, as specified in ACI 301.
   1. For trial mixtures method, employ independent testing agency acceptable to Architect for preparing and reporting proposed mix designs.

C. Admixtures: Add acceptable admixtures as recommended in ACI 211.1 and at rates recommended by manufacturer.

D. Concrete Properties:
   1. Compressive strength, when tested in accordance with ASTM C39/C39M at 28 days; 3,000 psi.
   2. Minimum Modulus of Rupture at Third Point Loading: 650 psi.
   3. Fly Ash Content: Maximum 20 percent of cementitious materials by weight.
   4. Cement Content: Minimum 6 sacks per cubic yard.
   5. Water-Cement Ratio: Maximum 45 percent by weight.
   6. Total Air Content: 5 to 7 percent, determined in accordance with ASTM C173/C173M.
   7. Maximum Slump: 4 inches.
   8. Maximum Aggregate Size: 1-1/2 inch.

2.8 MIXING

A. Transit Mixers: Comply with ASTM C94/C94M.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify compacted subgrade is acceptable and ready to support paving and imposed loads.

B. Verify gradients and elevations of base are correct.

3.2 SUBBASE

A. See Section 312300 for construction of base course for work of this Section.

3.3 PREPARATION

A. Moisten base to minimize absorption of water from fresh concrete.

B. Coat surfaces of manhole and catch basin frames with oil to prevent bond with concrete pavement.

3.4 FORMING

A. Place and secure forms to correct location, dimension, profile, and gradient.

B. Assemble formwork to permit easy stripping and dismantling without damaging concrete.

C. Place joint filler vertical in position, in straight lines. Secure to formwork during concrete placement.

3.5 REINFORCEMENT

A. Place reinforcement as indicated.

B. Interrupt reinforcement at expansion joints.

3.6 COLD AND HOT WEATHER CONCRETING

A. Follow recommendations of ACI 305R when concreting during hot weather.

B. Follow recommendations of ACI 306R when concreting during cold weather.

C. Do not place concrete when base surface temperature is less than 40 degrees F, or surface is wet or frozen.

3.7 PLACING CONCRETE

A. Place concrete in accordance with ACI 304R.

B. Do not place concrete when base surface is wet.

C. Ensure reinforcement, inserts, embedded parts, formed joints and similar items are not disturbed during concrete placement.

D. Place concrete continuously over the full width of the panel and between predetermined construction joints. Do not break or interrupt successive pours such that cold joints occur.

E. Place concrete to pattern indicated.

3.8 JOINTS

A. Place 1/2 inch wide expansion joints at 20 foot intervals and to separate paving from vertical surfaces and other components and in pattern indicated.
   1. Form joints with joint filler extending from bottom of pavement to within 3/4 inch of finished surface.
   2. Secure to resist movement by wet concrete.

B. Provide tooled joints.
   1. At spacing and layout indicated on Drawings.

3.9 FINISHING

A. Plaza and Patio Area Paving: Light broom, direction as indicated, with troweled and radiused edge; 1/4 inch radius.

B. Sidewalk Paving: Light broom, texture perpendicular to direction of travel with troweled and radiused edge; 1/4 inch radius.

C. Vehicular Paving: Light broom, texture perpendicular to direction of travel.

D. Curbs and Gutters: Light broom, texture parallel to pavement direction.

E. Place curing compound on exposed concrete surfaces immediately after finishing. Apply in accordance with manufacturer's instructions.

3.10 TOLERANCES

A. Maximum Variation of Surface Flatness: 1/4 inch in 10 ft.

B. Maximum Variation From True Position: 1/4 inch.

3.11 FIELD QUALITY CONTROL

A. An independent testing agency will perform field quality control tests, as specified in Section 01 4000 - Quality Requirements.
   1. Provide free access to concrete operations at project site and cooperate with appointed firm.
   2. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of concrete operations.
   3. Tests of concrete and concrete materials may be performed at any time to ensure conformance with specified requirements.

B. Compressive Strength Tests: ASTM C39/C39M. For each test, mold and cure five concrete test cylinders. Obtain test samples for every 100 cu yd or less of each class of concrete placed.
   1. Test one cylinder at 7 days, three at 28 days, and hold one for further testing, if necessary.
   2. Take one additional test cylinder during cold weather concreting, cured on job site under same conditions as concrete it represents.
   3. Perform one slump and air content test for each set of test cylinders taken.

C. Maintain records of placed concrete items. Record date, location of pour, quantity, air temperature, and test samples taken.

3.12 PROTECTION

A. Immediately after placement, protect pavement from premature drying, excessive hot or cold temperatures, and mechanical injury.

B. Do not permit pedestrian or vehicular traffic over pavement for 7 days minimum after finishing.

END OF SECTION 321313

SECTION 321373 - PAVEMENT JOINT SEALANTS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Expansion and contraction joints within portland cement concrete pavement.
2. Joints between portland cement concrete and asphalt pavement.

B. Related Sections include the following:

1. Division 2 Section "Cement Concrete Pavement" for constructing joints in concrete paving.
2. Division 7 Section "Joint Sealants" for sealing nontraffic and traffic joints in locations not specified in this Section.

1.3 SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. Samples for Verification: For each type and color of joint sealant required. Install joint-sealant samples in 1/2-inch- wide joints formed between two 6-inch- long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

C. Product Certificates: Signed by manufacturers of joint sealants certifying that products furnished comply with requirements and are suitable for the use indicated.

D. Product Test Reports: From a qualified testing agency indicating joint sealants comply with requirements, based on comprehensive testing of current product formulations.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has specialized in installing joint sealants similar in material, design, and extent to those indicated for this Project and whose work has resulted in joint-sealant installations with a record of successful in-service performance.

B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration date, pot life, curing time, and mixing instructions for multi-component materials.

B. Store and handle materials to comply with manufacturer's written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer or are below 40 deg F.
2. When joint substrates are wet.

B. Joint-Width Conditions: Do not proceed with installation of joint sealants where joint widths are less than that allowed by joint sealant manufacturer for application indicated.

C. Joint-Substrate Conditions: Do not proceed with installation of joint sealants until contaminants capable of interfering with their adhesion are removed from joint substrates.

PART 2 PRODUCTS

2.1 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint sealant manufacturer based on testing and field experience.

B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range for this characteristic.

2.2 COLD-APPLIED JOINT SEALANTS

A. Available Products: Subject to compliance with requirements, provide one of the following or equal:

1. Type NS Silicone Sealant for Concrete:
    a. Roadsaver Silicone-SL; Crafco Inc.
    b. 888; Dow Corning.
2. Type SL Silicone Sealant for Concrete and Asphalt:
    a. 890-SL; Dow Corning.
3. Multi-component Low-Modulus Sealant for Concrete and Asphalt:
    a. SOF-SEAL; W.R. Meadows, Inc.

2.3 HOT-APPLIED JOINT SEALANTS

A. Available Products: Subject to compliance with requirements, provide one of the following or equal:

1. Elastomeric Sealant for Concrete:
    a. Superseal 444/777; Crafco, Inc.
    b. Poly-Jet 3406; W.R. Meadows, Inc.
2. Sealant for Concrete and Asphalt:
    a. Roadsaver 221; Crafco Inc.
    b. Product #9005; Koch Materials Company.
    c. Product #9030; Koch Materials Company.
    d. Sealtight Hi-Spec; W.R. Meadows, Inc.

2.4 JOINT-SEALANT BACKER MATERIALS

A. General: Provide joint-sealant backer materials that are non-staining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by

joint sealant manufacturer based on field experience and laboratory testing.

B. Round Backer Rod for Cold- and Hot-Applied Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depths and prevent bottom-side adhesion of sealant.

C. Backer Strips for Cold- and Hot-Applied Sealants: ASTM D 5249; Type 2; of thickness and width required to control sealant depths, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

D. Round Backer Rods for Cold-Applied Sealants: ASTM D 5249, Type 3, of diameter and density required to control sealant depths and prevent bottom-side adhesion of sealant.

2.5 PRIMERS

A. Primers: Product recommended by joint sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from pre-construction joint- sealant-substrate tests and field tests.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint sealant manufacturer's written instructions.

B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint sealant manufacturer, based on pre-construction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint sealant manufacturer's written installation instructions applicable to products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations of ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install backer materials of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of backer materials.
2. Do not stretch, twist, puncture, or tear backer materials.
3. Remove absorbent backer materials that have become wet before sealant application and replace them with dry materials.

D. Install sealants by proven techniques to comply with the following and at the same time backings are installed:

1. Place sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses provided for each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

E. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealants from surfaces adjacent to joint.
2. Use tooling agents that are approved in writing by joint sealant manufacturer and that do not discolor sealants or adjacent surfaces.

F. Provide joint configuration to comply with joint sealant manufacturer's written instructions, unless otherwise indicated.

G. Provide recessed joint configuration for silicone sealants of recess depth and at locations indicated.

3.4 CLEANING

A. Clean off excess sealants or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from the original work.

END OF SECTION 321373

SECTION 321723.13 - PAINTED PAVEMENT MARKINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Parking lot markings, including parking bays, crosswalks, arrows, and handicapped symbols.

1.2 REFERENCE STANDARDS

A. MPI (APL) - Master Painters Institute Approved Products List; Master Painters and Decorators Association.

B. FHWA MUTCD - Manual on Uniform Traffic Control Devices for Streets and Highways; U.S. Department of Transportation, Federal Highway Administration; http://mutcd.fhwa.dot.gov.

1.3 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver paint in containers of at least 5 gallons accompanied by batch certificate.

B. Store products in manufacturer's unopened packaging until ready for installation.

C. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.5 FIELD CONDITIONS

A. Do not install products under environmental conditions outside manufacturer's absolute limits.

PART 2 PRODUCTS

2.1 MATERIALS

A. Line and Zone Marking Paint: MPI No. 97 Latex Traffic Marking Paint; color(s) as specified.
   1. Drive Lanes: Yellow.
   2. Parking Lots: White.
   3. Handicapped Symbols: Blue and white.

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Allow new pavement surfaces to cure for a period of not less than 14 days before application of marking materials.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

C. Clean surfaces thoroughly prior to installation.
   1. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water, or a combination of these methods.

D. Where oil or grease are present, scrub affected areas with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinse thoroughly after each application; after cleaning, seal oil-soaked areas with cut shellac to prevent bleeding through the new paint.

E. Establish survey control points to determine locations and dimensions of markings; provide templates to control paint application by type and color at necessary intervals.

3.3 INSTALLATION

A. Begin pavement marking as soon as practicable after surface has been cleaned and dried.

B. Do not apply paint if temperature of surface to be painted or the atmosphere is less than 50 degrees F or more than 95 degrees F.

C. Apply in accordance with manufacturer's instructions using an experienced technician that is thoroughly familiar with equipment, materials, and marking layouts.

D. Comply with FHWA MUTCD manual (http://mutcd.fhwa.dot.gov) for details not shown.

E. Apply markings in locations determined by measurement from survey control points; preserve control points until after markings have been accepted.

F. Apply uniformly painted markings of color(s), lengths, and widths as indicated on the Drawings true, sharp edges and ends.
   1. Apply paint in one coat only.
   2. Wet Film Thickness: 0.015 inch, minimum.
   3. Length Tolerance: Plus or minus 2 inches.
   4. Width Tolerance: Plus or minus 1/8 inch.

G. Parking Lots: Apply parking space lines, entrance and exit arrows, painted curbs, and other markings indicated on Drawings.
   1. Mark the International Handicapped Symbol at indicated parking spaces.
   2. Hand application by pneumatic spray is acceptable.

H. Symbols: Use a suitable template that will provide a pavement marking with true, sharp edges and ends, of the design and size indicated.

3.4 DRYING, PROTECTION, AND REPLACEMENT

A. Protect newly painted markings so that paint is not picked up by tires, smeared, or tracked.

B. Provide barricades, warning signs, and flags as necessary to prevent traffic crossing newly painted markings.

C. Allow paint to dry at least the minimum time specified by the applicable paint standard and not less than that recommended by the manufacturer.

D. Remove and replace markings that are applied at less than minimum material rates; deviate from true alignment; exceed length and width tolerances; or show light spots, smears, or other deficiencies or irregularities.

E. Remove markings in manner to avoid damage to the surface to which the marking was applied, using carefully controlled sand blasting, approved grinding equipment, or other approved method.

F. Replace removed markings at no additional cost to Owner.

END OF SECTION 321723.13

SECTION 323116 – ORNAMENTAL WELDED WIRE FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Welded wire mesh, modular fencing panels, tubular steel posts and gates, and vehicle card reader pedestals and hoods.

B. Related sections:

1. Section 033000 - Cast-in-Place Concrete: Concrete footings for support of fence posts.

1.2 REFERENCES

A. ASTM International (ASTM):

1. ASTM A36 - Carbon Structural Steel.

2. ASTM A123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

3. ASTM A500 - Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

4. ASTM A526 - Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Commercial Quality.

5. ASTM A792 - Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.

6. ASTM B117 - Operating Salt Spray (Fog) Apparatus.

7. ASTM D822 - Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings.

8. ASTM D2794 - Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).

9. ASTM D3363 - Test Method for Film Hardness by Pencil Test.

1.3 SUBMITTALS

A. Provide in accordance with Section 013300 - Submittal Procedures:

1. Product data for components and accessories.

2. Shop drawings showing layout, dimensions, spacing of components, and anchorage and

installation details.

3. Sample: 8” x 10” minimum size sample of fence panel illustrating design, fabrication workmanship, and selected color coating.

4. Copy of warranty specified in Paragraph 1.4 for review by Architect.

1.4 WARRANTY

A. Provide in accordance with Section 017700 - Closeout Procedures:

1. Factory finish: 20-year warranty against cracking, peeling, and blistering under normal use.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Fences and Gates - Ametco Manufacturing Corporation, 4326 Hamann Parkway, P.O. Box 1210, Willoughby, Ohio 44096; (800) 362-1360.

B. Vehicle Card Reader Pedestals and Hoods – Pedestal CEO, 561 Wilderness Dr, Alpine, UT 84004-1404, (800) 660-3072.

C. Requests to use equivalent products of other manufacturers shall be submitted in accordance with Section 012513 - Product Substitution Procedures.

2.2 MATERIALS

A. Wire: Galvanized steel wire.

B. Steel bar stock: ASTM A36.

C. Steel tubing: ASTM A500, Grade B.

D. Steel sheet: ASTM A526 galvanized or ASTM A792 Galvalume.

E. Grout: Non-shrink type, pre-mixed compound consisting of non-metallic aggregate, cement, and water-reducing and plasticizing additives.

2.3 FENCE SYSTEM

A. Type: Ornamental steel fencing system consisting of welded wire mesh modular fence panels, tubular steel posts, and strap-type panel fasteners and designed for medium- and high-security applications; Fiesta Design as manufactured by Ametco Manufacturing Corporation.

B. Fence panels: Fabricated from galvanized wire welded to form open mesh.

1. Vertical wires: 1/4” diameter spaced at 2”

2. Horizontal wires: Two 5/16” diameter wires encasing vertical wires and spaced at 8”

3. Pickets: Form by extending vertical wires 1” above top horizontal wire.

4. Size: Provide two sizes.

1. Standard: 98-13/16” wide by 72” high at enclosure

2. Custom: To fit 96” wide x 72” high on center posts. Refer to Sheet A543

5. Panel fastener: K-shaped strap fastener, synthetic retainer, and safety screw to anchor panels to face of post.

2.4 POSTS

A. Type: Steel tubes fabricated from ASTM A526 galvanized steel or ASTM A792 Galvalume steel as selected by manufacturer for type and size of fencing. Provide post faced with vertical, V-shaped, recessed channels to receive wire edge of fence panel.

B. Size:

1. Fence posts: 3” by 3”

2. Gate posts: 4” by 4”

C. Wall thickness: 12 gauge

D. Length: 72” above grade

E. Equip posts with plastic top caps.

F. Factory drill posts to receive fence panel attachment fasteners.

2.5 GATES

A. Type: Hinged swinging double gate

1. Construction: Welded frame fabricated from 2” by 2” steel tubing with welded wire panel to match fencing.

2. Nominal size: 15’-10” x 6’- 0” refer to Sheet A543

3. Hardware: Equip gates with manufacturer's standard hardware required for functional operation.

a. Hinges: Size and type as determined by manufacturer. Provide 2 hinges for each leaf up to 6' height and 1 additional hinge for each additional 24" in height or fraction thereof.

b. Latch: 3/4" slide bolt to accommodate padlock.

c. For double gates provide padlockable, center cane bolt assembly and strike.

B. Type: V-wheeled rolling gates.

1. Construction: Welded frame fabricated from 3" x 3" steel tubing with open grille steel panels to match fencing material. 8" x 3" bottom rail. Frame configuration shall be as indicated on Drawings and approved shop drawings.

2. Nominal size:

a. Gate opening: 14'-0"

b. Gate: 21' wide by 6' high. Refer to Sheet A543

c. Gate travel distance: 14'

3. Support posts: Pair of 4" diameter tubular steel posts with solid cap.

4. Rolling mechanism: Steel wheels with V-shaped edge groove and 6" diameter, mounted to gate frame and riding on ground set V-track. Assembly braced at top by adjustable guide wheels mounted with brackets to support posts.

2.6 FACTORY FINISH

A. Steel fence panels and posts shall be hot-dip galvanized to 1.25 ounces per square foot minimum zinc coating in accordance with ASTM A123 or provided with Galvalume coating complying with ASTM A792. Standard size components shall receive polyester powder coating. Large gate panels shall be coated with 2-part polyurethane coating.

B. Polyester powder coating: Electrostatically applied colored polyester powder coating heat cured to chemically bond finish to metal substrate.

1. Minimum hardness measured in accordance with ASTM D3363: 2H.

2. Direct impact resistance tested in accordance with ASTM D2794. Withstand 160 inch-pounds.

3. Salt spray resistance tested in accordance with ASTM B117: No undercutting, rusting, or blistering after 500 hours in 5% salt spray at 95 °F and 95% relative humidity and after 1000 hours less than 3/16" undercutting.

4. Weatherability tested in accordance with ASTM D822: No film failure and 88% gloss retention after 1 year exposure in South Florida with test panels tilted at 45°.

C. Polyurethane coating: 1.0 mil dry film thickness of coating of steel test panel cured 30 minutes at 180 °F and aged 14 days shall resist the following test conditions without failure:

1. 5% salt spray for 500 hours.

2. 100% relative humidity for 1000 hours.

3. Water immersion for 100 hours.

4. 20 double rubs with cloth saturated with either lacquer thinner, acetone, MEK, gasoline, or xylene.

5. Exposure to lubricating oils, hydraulic fluids, and cutting oils.

6. 16 cycles of 24 hours at 100% humidity, 24 hours at 10 °F, and 24 hours at 77 °F.

7. Hardness: H to 2H.

8. Flexibility: 1/8” conical mandrel.

D. Color: Selected by Architect from manufacturer's standard range

2.7 VEHICLE CARD READER PEDESTALS

A. Pedestal CEO Model Number: 42-3-12

B. Height: 42”

C. Finish: Black Wrinkle TGIC Outdoor Polyester Powder Coat

D. Face Plate: 4.75” x 4.75”, 8-hole pattern, 0.136” CRS

E. Base Plate: 8” x 8”, holes on 3.25” and 5.00” centers, 0.25” CRS, with cover plate

F. Tube: 3” x 3” square, 0.120” wall (11-gauge)

G. Neck: 12” reach (on vertical center), two 45° cuts and welded

H. Material: Heavy gauge steel

I. Hardware: Four 1/4-20 carriage bolts and nuts per face plate

2.8 VEHICLE CARD READER HOODS

A. Pedestal CEO Model Number: HOOD-CS-4.5X6

B. Height: 6”

C. Width: 4.5”

D. Top Overhang: 3.5”, tapers to 1.75” at sidewall bottom

E. Finish: Black Wrinkle TGIC Outdoor Polyester Powder Coat

F. Knockouts: Quantity = 8; 0.25” diameter

G. Center Hole: 1.75” diameter

H. Material Thickness: 16 gauge

PART 3 - EXECUTION

3.1 PREPARATION

A. Prior to fabrication, field verify required dimensions.

B. Coordinate fence and gate installation with provision of gate operator specified in Section 323111 - Gate Operators to ensure proper power supply and that conduit and wiring are concealed.

C. Cast concrete footings in accordance with Section 033000 - Cast-in-Place Concrete as detailed on Drawings and approved shop drawings.

1. Minimum footing diameter:

a. Terminal and gate posts: 12”

b. Intermediate line posts: 10”

2. Allow 8” minimum embedment of posts.

3. Allow 6” minimum concrete beneath post bottom.

4. For vehicle card reader pedestals, prepare concrete footings in accordance with the manufacturer’s installation instructions.

3.2 INSTALLATION

A. Install fencing in accordance with manufacturer's installation instructions and approved shop drawings.

B. Install fence posts plumb and level by embedding post directly in concrete footing. Temporarily brace fence posts with 2 x 4 wood supports until concrete is set.

C. Do not install bent, bowed, or otherwise damaged panels. Remove damaged components from site and replace.

D. Install fence panels to posts after posts have been set in footings and concrete is cured.

5. Secure wire fence panels with fastener type as recommended by manufacturer.

6. Space fasteners and secure to posts at spacing indicated on approved shop drawings.

7. Attach channel-shaped connectors over joints between abutting horizontal bars.

E. Gates:

1. Install gates and adjust hardware for smooth operation.

2. Provide concrete center foundation depth and drop rod retainers at center of double swinging gate openings.

3. Provide concrete surface for length of operation of V-wheeled rolling gate. Anchor track to concrete with countersunk fasteners.

4. After installation, test gate and operator. Open and close a minimum of five times. Correct deficiencies and adjust.

F. Attach plastic caps to steel posts.

G. Touch-up damaged finish with paint supplied by manufacturer and matching original coating.

H. Install vehicle card reader pedestals and hoods in accordance with the manufacturer's installation instructions.

END OF SECTION 323116

SECTION 331000 - WATER DISTRIBUTION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Pipe and fittings for site water lines including domestic water lines and fire water lines.

B. Valves, Fire hydrants, and Domestic water hydrants.

1.2 RELATED REQUIREMENTS

A. Section 31 2300 - Earthwork: Excavating of trenches, bedding and backfilling

B. Section 33 1300 - Disinfection of Water Distribution System: Disinfection of site service utility water piping.

C. Section 33 0513 - Manholes and Covers.

D. Section 03 3000 - Cast-in-Place Concrete: Concrete for thrust restraints.

E. Section 09 9000 - Paints and Coatings.

1.3 REFERENCES

A. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; 2001 (R2005) (ANSI B16.18).

B. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; The American Society of Mechanical Engineers; 2001 (R2005).

C. ASTM B 88 - Standard Specification for Seamless Copper Water Tube; 2003.

D. ASTM D 1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2006.

E. ASTM D 2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40; 2006.

F. ASTM D 2855 - Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings; 1996 (Reapproved 2002).

G. ASTM D 3035 - Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter; 2006.

H. ASTM D 3139 - Standard Specification for Joints for Plastic Pressure Pipes using Flexible Elastomeric Seals; 1998 (Reapproved 2005).

I. AWS A5.8/A5.8M - Specification for Filler Metals for Brazing and Braze Welding; American Welding Society; 2004 and errata.

J. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems; American Water Works Association; 2005 (ANSI/AWWA C105/A21.5).

K. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings; American Water Works Association; 2007 (ANSI/AWWA C111/A21.11).

L. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast, for Water; American Water Works Association; 2002, and Errata 2002 (ANSI/AWWA C151/A21.51).

M. AWWA C500 - Metal-Seated Gate Valves for Water Supply Service; American Water Works Association; 2002.

N. AWWA C502 - Dry Barrel Fire Hydrants; American Water Works Association; 2005 (ANSI/AWWA C502/C502a).

O. AWWA C504 - Rubber Seated Butterfly Valves; American Water Works Association; 2006.

P. AWWA C508 - Swing-Check Valves for Waterworks Service, 2 In. (50 mm) Through 24 In. (600 mm) NPS; American Water Works Association; 2001 (ANSI/AWWA C508).

Q. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances; American Water Works Association; 2005 (ANSI/AWWA C600).

R. AWWA C606 - Grooved and Shouldered Joints; American Water Works Association; 2006.

S. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Distribution; American Water Works Association; 2007 (ANSI/AWWA C900/C900a).

T. AWWA C901 - Polyethylene (PE) Pressure Pipe and Tubing, 1/2 In. (13 mm) Through 3 In. (76 mm), for Water Service; American Water Works Association; 2002.

U. UL 246 - Hydrants for Fire-Protection Service; Underwriters Laboratories Inc.; 1993.

1.4 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data on pipe materials, pipe fittings, valves and accessories.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Project Record Documents: Record actual locations of piping mains, valves, connections, thrust restraints, and invert elevations. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with utility company requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store valves in shipping containers with labeling in place.

PART 2 PRODUCTS

2.1 WATER PIPE

A. Ductile Iron Pipe: AWWA C151:

1. Fittings: Ductile iron, standard thickness.
2. Joints: AWWA C111, rubber gasket with rods.
3. Jackets: AWWA C105 polyethylene jacket.

B. Copper Tubing: ASTM B 88, Type K, annealed:

1. Fittings: ASME B16.18, cast copper, or ASME B16.22, wrought copper.
2. Joints: Compression connection or AWS A5.8, BCuP silver braze.

C. PVC Pipe: ASTM D 1785, Schedule 40.

1. Fittings: ASTM D 2466, PVC.
2. Joints: ASTM D 2855, solvent weld.

D. PVC Pipe: AWWA C900 Class 100:

1. Fittings: AWWA C111, cast iron.
2. Joints: ASTM D 3139 compression gasket ring.

E. Polyethylene Pipe: ASTM D 3035, for 45 psig pressure rating:

1. Fittings: AWWA C901, molded or fabricated.
2. Joints: Compression.

F. Trace Wire: Magnetic detectable conductor, clear plastic covering, imprinted with "Water Service " in large letters.

2.2 VALVES

A. Valves: Manufacturer's name and pressure rating marked on valve body.

B. Gate Valves Up To 3 Inches:

1. Brass or Bronze body, non-rising stem, inside screw, single wedge or disc, compression ends, with control rod, post indicator, valve key, and extension box.
2. Substitutions: See Section 01 60 00 - Product Requirements.

C. Gate Valves 3 Inches and Over:

1. AWWA C500, iron body, bronze trim, non-rising stem with square nut, single wedge, flanged ends, control rod, post indicator, valve key, and extension box.
2. Substitutions: See Section 01 60 00 - Product Requirements.

D. Ball Valves Up To 2 Inches:

1. Brass body, Teflon coated brass ball, rubber seats and stem seals, Tee stem pre-drilled for control rod, AWWA inlet end, compression outlet with electrical ground connector, with control rod, valve key, and extension box.
2. Substitutions: See Section 01 60 00 - Product Requirements.

E. Swing Check Valves From 2 Inches to 24 Inches:

1. AWWA C508, iron body, bronze trim, 45 degree swing disc, renewable disc and seat, flanged ends.
2. Substitutions: See Section 01 60 00 - Product Requirements.

F. Butterfly Valves From 2 Inches to 24 Inches:

1. AWWA C504, iron body, bronze disc, resilient replaceable seat, water or lug ends, ten position lever handle.
2. Substitutions: See Section 01 60 00 - Product Requirements.

2.3 HYDRANTS

A. Hydrants: AWWA C502, UL 246, dry barrel type.

1. Inside dimension: 7 inches minimum, with minimum 5 inches diameter valve seat opening.
2. Minimum net water area of barrel not less than 190 percent of valve opening.
3. 6 inch bell or mechanical joint inlet connection with accessories, gland bolts, and gaskets.

4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Hydrant Extensions: Fabricate in multiples of 6 inches with rod and coupling to increase barrel length.

C. Hose and Streamer Connection: Match sizes with utility company, two hose nozzles, one pumper nozzle.

D. Finish: Primer and two coats of enamel in color required by utility company.

2.4 BEDDING AND COVER MATERIALS

A. Bedding: As specified in Section 31 2300.

B. Cover: As specified in Section 31 2300.

2.5 ACCESSORIES

A. Concrete for Thrust Restraints: Concrete type specified in Section 03 3000.

B. Manhole and Cover: Refer to Section 31 2323.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that building service connection and municipal utility water main size, location, and invert are as indicated.

3.2 PREPARATION

A. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, remove burrs.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare pipe connections to equipment with flanges or unions.

3.3 TRENCHING

A. See the sections on excavation and fill for aditional requirements.

B. Hand trim excavation for accurate placement of pipe to elevations indicated.

C. Form and place concrete for pipe thrust restraints at each change of pipe direction. Place concrete to permit full access to pipe and pipe accessories. Provide 2 sq ft thrust restraint bearing on subsoil.

D. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

3.4 INSTALLATION - PIPE

A. Maintain separation of water main from sewer piping in accordance with New Mexico APWA code.

B. Group piping with other site piping work whenever practical.

C. Establish elevations of buried piping to ensure not less than 1.5 ft of cover.

D. Install pipe to indicated elevation to within tolerance of 5/8 inches.

E. Install ductile iron piping and fittings to AWWA C600.

F. Install grooved and shouldered pipe joints to AWWA C606.

G. Route pipe in straight line.

H. Install pipe to allow for expansion and contraction without stressing pipe or joints.

I. Install access fittings to permit disinfection of water system performed under Section 33 1300.

J. Slope water pipe and position drains at low points.

K. Install trace wire 6 inches above top of pipe; coordinate with Section 31 2300.

3.5 INSTALLATION - VALVES AND HYDRANTS

A. Set valves on solid bearing.

B. Center and plumb valve box over valve. Set box cover flush with finished grade.

C. Set hydrants plumb; locate pumper nozzle perpendicular to and facing roadway.

D. Set hydrants to grade, with nozzles at least 20 inches above ground.

E. Locate control valve 4 inches away from hydrant.

F. Provide a drainage pit 36 inches square by 24 inches deep filled with 2 inches washed gravel. Encase elbow of hydrant in gravel to 6 inches above drain opening. Do not connect drain opening to sewer.

G. Paint hydrants in accordance with Section 09 9000.

3.6 SERVICE CONNECTIONS

A. Provide water service to utility company requirements with reduced pressure backflow preventer and water meter with by-pass valves and sand strainer.

B. Provide sleeve in retaining wall for service main. Support with reinforced concrete bridge. Calk enlarged sleeve watertight.

C. Anchor service main to interior surface of foundation wall.

D. Provide 18 gage galvanized sheet metal sleeve surrounding service main to 6 inches above floor and 6 feet minimum below grade. Size for 2 inches minimum of glass fiber insulation stuffing.

3.7 FIELD QUALITY CONTROL

A. Perform field inspection and testing in accordance with Section 01 4000.

B. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.

END OF SECTION 331000

SECTION 333000 - SANITARY SEWER PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Sanitary sewerage drainage piping, fittings, and accessories.

B. Connection of building sanitary drainage system to municipal sewers.

1.2 RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete: Concrete for cleanout base pad construction.

1.3 DEFINITIONS

A. Bedding: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

1.4 REFERENCE STANDARDS

A. ASTM A 74 - Standard Specification for Cast Iron Soil Pipe and Fittings; 2006.

B. ASTM A 746 - Standard Specification for Ductile Iron Gravity Sewer Pipe; 2003.

C. ASTM C 12 - Standard Practice for Installing Vitrified Clay Pipe Lines; 2008.

D. ASTM C 14 - Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe; 2007.

E. ASTM C 14M - Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe [Metric]; 2007.

F. ASTM C 425 - Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings; 2004.

G. ASTM C 443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets; 2005a.

H. ASTM C 443M - Standard Specification for Joints for Circular Concrete Culvert and Sewer Pipe, Using Rubber Gaskets (Metric); 2007.

I. ASTM C 564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings; 2003a.

J. ASTM C 700 - Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated; 2007a.

K. ASTM D 2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications; 2008.

L. ASTM D 2751 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings; 2005.

M. AWWA C111/A21.11 - American National Standard for Rubber Gasket Joints For Cast Iron and Ductile Iron Pressure Pipe and Fittings; 2007. (ANSI/AWWA C111/A21.11)

1.5 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data indicating pipe, pipe accessories.

C. Manufacturer's Installation Instructions: Indicate special procedures required to install Products specified.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Project Record Documents:

1. Record location of pipe runs, connections, catch basins, cleanouts, and invert elevations.
2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.6 REGULATORY REQUIREMENTS

A. Conform to applicable code for materials and installation of the Work of this section.

PART 2 PRODUCTS

2.1 SEWER PIPE MATERIALS

A. Cast Iron Soil Pipe: ASTM A 74, Service type, hub and spigot end.

B. Joint Seals for Cast Iron Pipe: ASTM C 564 rubber gaskets.

C. Ductile Iron Pipe: ASTM A 746, Pressure Class 350, with asphaltic lining, bell and spigot end.

D. Joint Seals for Ductile Iron Pipe: AWWA C111/A21.11 rubber gaskets.

E. Vitrified Clay Pipe: ASTM C 700, Extra strength, unperforated; bell and spigot end joints.

F. Joint Seals for Clay Pipe: ASTM C 425 compression gasket joint devices.

G. Concrete Pipe: Nonreinforced, ASTM C 14 (ASTM C 14M), Class 1; bell and spigot end joints.

H. Joint Seals for Concrete Pipe: ASTM C 443 (ASTM C 443M) rubber compression gaskets.

I. Joint Seals for Concrete Pipe: ASTM C 443 (ASTM C 443M) rubber compression gaskets.

J. Plastic Pipe: ASTM D 2751, SDR 23.5, Acrylonitrile-Butadiene-Styrene (ABS) material; bell and spigot style solvent sealed joint end.

K. Joint Seals: Mechanical clamp ring type, stainless steel expanding and contracting sleeve, neoprene ribbed gasket for positive seal.

L. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps and other configurations required.

2.2 PIPE ACCESSORIES

A. Trace Wire: Magnetic detectable conductor, clear plastic covering, imprinted with "Sewer Service " in large letters.

2.3 CLEANOUT MANHOLE

A. Lid and Frame: Cast iron construction, hinged lid.

1. Lid Design: Open checkerboard grill.
2. Nominal Lid and Frame Size: 26 inches.

B. Acceptable Products:

1. Substitutions: See Section 01 6000 - Product Requirements.

C. Shaft Construction and Concentric Cone Top Section: Reinforced precast Concrete pipe sections, lipped male/female dry joints, cast steel ladder rungs into shaft sections at 12 inches; nominal shaft diameter of 36 inches.

D. Base Pad: Cast-in-place concrete of type specified in Section 03 3000, levelled top surface to receive concrete shaft sections, sleeved to receive sanitary sewer pipe sections.

2.4 BEDDING AND COVER MATERIALS

A. Pipe Bedding Material: As specified in Section 31 2300.

B. Pipe Cover Material: As specified in Section 31 2300.

PART 3 EXECUTION

3.1 TRENCHING

A. See Section 31 2300 for additional requirements.

B. Hand trim excavation for accurate placement of pipe to elevations indicated.

C. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

3.2 INSTALLATION - PIPE

A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on layout drawings.

B. Install pipe, fittings, and accessories in accordance with manufacturer's instructions. Seal watertight.

1. Clay Pipe: Also comply with ASTM C 12.
2. Plastic Pipe: Also comply with ASTM D 2321.

C. Lay pipe to slope gradients noted on layout drawings; with maximum variation from true slope of 1/8 inch in 10 feet.

D. Connect to building sanitary sewer outlet, through installed sleeves.

E. Install trace wire 6 inches above top of pipe; coordinate with Section 31 2300.

3.3 INSTALLATION - CLEANOUTS

A. Form bottom of excavation clean and smooth to correct elevation.

B. Form and place cast-in-place concrete base pad, with provision for sanitary sewer pipe end sections.

C. Establish elevations and pipe inverts for inlets and outlets as indicated.

D. Mount lid and frame level in grout, secured to top cone section to elevation indicated.

3.4 FIELD QUALITY CONTROL

A. Perform field inspection and testing in accordance with Section 01 4000.

B. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.

3.5 PROTECTION

A. Protect pipe and bedding cover from damage or displacement until backfilling operation is in progress.

END OF SECTION 333000